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PETROLEUM REFINER

REFINING | PETROCHEMICALS | NATURAL GASOLINE

API—Natural Gasoline Special Issue

- **What products will we be making in 1965?**
- **New process desulfurizes crude oil.**
- **Are perforated plates here to stay?**

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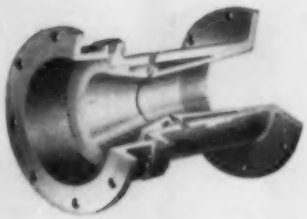

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Volume 34, No. 5 May, 1955

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REFINER
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A Quick Look
at This Issue

Busy oil men can put first things first by scanning Quick Look's handy digests and checking ✓ those they want to read first

API REFINING TOPICS

☐ **What We'll Be Making in 10 Years . . .** The refinery of 1965 will be quite different from today's set-up. Here's a look at the way product demand will change. Cat reforming will be making more of the gasoline demand than cat cracking. Coke and LPG will be more in demand. **Page 139.**

☐ **Ammonia from Cat Reformer Off-Gas . . .** Hydrogen produced in the off-gas of catalytic reforming is not suitable for ammonia synthesis without additional preparation. Here is a comparison of six methods for purifying the hydrogen on the basis of cost of ammonia product and operating variables. **Page 145.**

☐ **Improving Distillates by Hydrofining . . .** Distillates from crude oils high in sulfur or aromatics content can't be finished to high-quality fuels by conventional sweatening methods; but here's a slick way out. Hydrofining of a distillate from high-sulfur West Texas crude improved its quality to that of Mid-Continent distillate, with no loss of liquid products. **Page 153.**

☐ **Gulf HDS Process Upgrades Crudes . . .** This new hydrodesulfurization process brings hydrogenation of heavy stocks considerably closer to economic realization. Operated at moderate pressures, the process converts heavy residual fractions to lower-boiling distillate products while simultaneously effecting substantial desulfurization of all fractions of the charge stock. Rugged catalyst maintains good activity after repeated regeneration in spite of deposition of metallic contaminants. Page 156.

☐ **Neutralizers and Inhibitors Form Basis of Chemical Corrosion Control . . .** To slow or stop the corrosive attack of a fluid on a metal surface, it is necessary to do something to the metal or the fluid, the latter being generally more economical. The author

→ Now Turn the Page →

gives a complete picture of neutralizers and inhibitors used separately and in combination to combat corrosion. Also presented is considerable data on the cost and effectiveness of various applications of inhibitors and neutralizers. Page 163.

☐ **Contract Turnaround Work . . .** Labor requirements for peak turnaround loads can be obtained in several ways. One effective way is to maintain a stable refinery work force and utilize contracted labor to supply the peak loads. Here is a description of the use of this system by a West Coast company. Page 170.

☐ **Design for Low Maintenance . . .** Maintenance of a plant can be greatly facilitated if the factors making for low maintenance are taken into consideration in the original design. The author describes the procedure used in the design of two European plants which resulted in simplified and economical maintenance. Page 174.

☐ **Needed: A New Knock-Test Unit . . .** ASTM is working to improve precision of knock testing; but the work load will be tremendous to obtain significant improvements in 2 to 3 years. Possible savings: $12 million per year. Aviation gasoline supplies can be increased by the same approach. Page 177.

NGAA TOPICS

☐ **Number of Trays—What's Their Effect? . . .** What happens to the over-all efficiency? Do the theoretical trays increase proportionally with an increase in actual trays. Of course you've wondered about these questions right along. Here are the answers, based on test data on a 45-inch diameter column. Page 185.

☐ **Perforated Plates vs. Bubble Caps . . .** Here is the answer to your question about perforated plates. This author gives you the answer from data obtained from large six-foot diameter towers. Sounds like the perforated plates are here to stay. Page 188.

☐ **Underground Storage Assumes Stature . . .** Author lets you in on the past, present and future of this mature development. Washing techniques are discussed in detail as well as several other problems you must face before embarking on an underground storage venture. Page 193.

☐ **What's New in Equilibrium Ratios? . . .** Here is a review of the recent thermodynamic developments in calculation of equilibrium constants from the equations of state. The newest empirical correlations are also discussed. A comparison of the results of the various methods is tabulated. To bring yourself up-to-date, turn to Page 198.

☐ **Tioga Plant Accounts for Weather . . .** Everybody's talking about this plant which had to be designed for varying temperatures of -30° F in the winter to 100 in the summer. Water wasn't readily available either. You find all the design conditions for these problems in this article. Page 201.

☐ **How to Protect Cooling Tower Headers . . .** Two years of testing show that protective coatings can control corrosion of piping headers to cooling towers and reduce the maintenance expense. Coatings employed included vinyl, expoxy ester or modified phenolic resin paints. How the coating is applied is an important item. Page 204.

☐ **Cut Corrosion in Dehydration Unit . . .** This control program reduced corrosion in the rich glycol solution, the lean glycol solution and in the dried gas line of a dehydration unit. Test coupons gave an indication of the program's effectiveness, but equipment inspection was needed to pin down the treatment completely. The program requires continual attention. Page 208.

☐ **A Case History in Plant Corrosion . . .** Here's how two gasoline plants used organic inhibitor treatment and the injection of alkaline boiler blowdown water to raise the pH of acidic waters. Progress data indicate the effectiveness of treatment at troublemaking spots. Page 213.

☐ **Saving Talents of Handicapped Workers . . .** It's not what a handicapped worker can't do, but what he can do that counts. Here's a technique that will improve your relationship with your employes—and save you money in the bargain. Page 136.

☐ **How to Prepare an Annual Report . . .** An annual report should be the most eloquent exponent of a company's performance. Is yours a bright, factual, human document? Does it present your problems as well as your achievements? Does it really work for your company's good? Here are some valuable tips from an authority who has judged more than 60,000 such reports in the last 14 years. Page 250.

☐ **They Speak Up for Du Pont . . .** These emissaries of the chemical industry are taking the good word about technical progress directly to the public. Last year they spoke 859 times before a combined audience of 136,089. For an effective concept of how to win friends, turn to Page 261.

☐ **Safe Driving Cuts Costs . . .** A reckless driver is a wasteful driver. Not only is it safer to reduce speed; it is more economical. For some common-sense rules of the road that will save lives, time and money, turn to Page 267.

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These Jets— Where Are They Taking Us?

JETS ARE making the news every day. Two commercial airlines are starting turboprop service in North America. The military is increasing its jet change-over by the day. Jet fuel consumption will jump 35 percent this year, the largest for any product. Refineries are now making more jet fuel than lubricating oil.

The editors of PETROLEUM REFINER have been watching these developments closely and coming next month we'll present an up-to-the-minute symposium on what the refiner's stake is in this development. We're promising a complete picture of the demand, availability, specifications and pricing of jet fuels as well as a case history in its manufacture.

Jets in June!

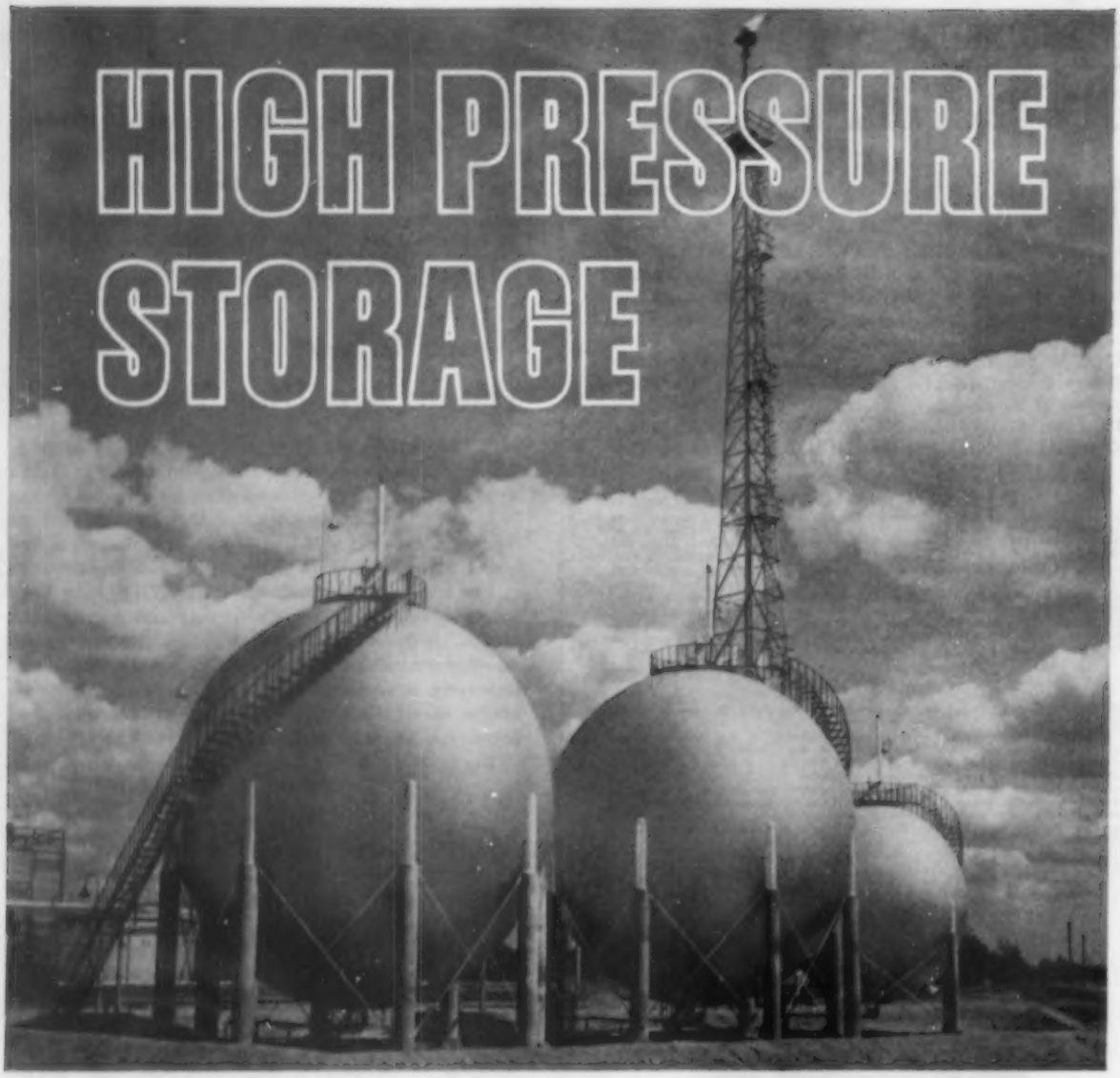
Management Articles Also for "To-Be's"

JUST ABOUT two years ago the decision was made to bring PETROLEUM REFINER readers a section dedicated to management topics. It was, and still is, a pioneer effort among those magazines serving the field of petroleum refining; for while many have offered material of interest to management, none other has attempted to constrict this broad area into a single packaged and balanced section—a section aimed at crisscrossing the corridors of occupational interests with material of interest to all, and in language that all can understand.

The choice of the title, "As Management Sees It," was one of expedience. More definitive, but too cumbersome, would have been, "For Management and Management-to-be." Such a title would encompass everybody in an organization down to, and including those wielders of shovels not content with their lot. The publisher put it this way when defining the objectives of the section when it was planned:

"Management is anyone who directs a group of men, no matter how small, or who aspires one of these days to be in charge of men."

And to all in these categories we heartily commend the offerings under the "As Management Sees It" label. More than that, we think all these men should read 'em!



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solve gas and liquid storage problems

For pressure storage of process butane, iso-butane, natural gasoline and other volatile liquids and gases, Graverspheres are a "natural."

Graverspheres are formed in Graver shops and are first carefully assembled to insure accurate fit. After this they are shipped to location, erected and field-welded.

These spheres—the very shape of which is ideal for high-pressure storage in quantity—are available in capacities from 1,000 to 30,000 bbl. For gas storage Graverspheres are made to withstand pressures up to 100 p.s.i.g. and for liquid storage from 20 to 90 lb. water pressure.

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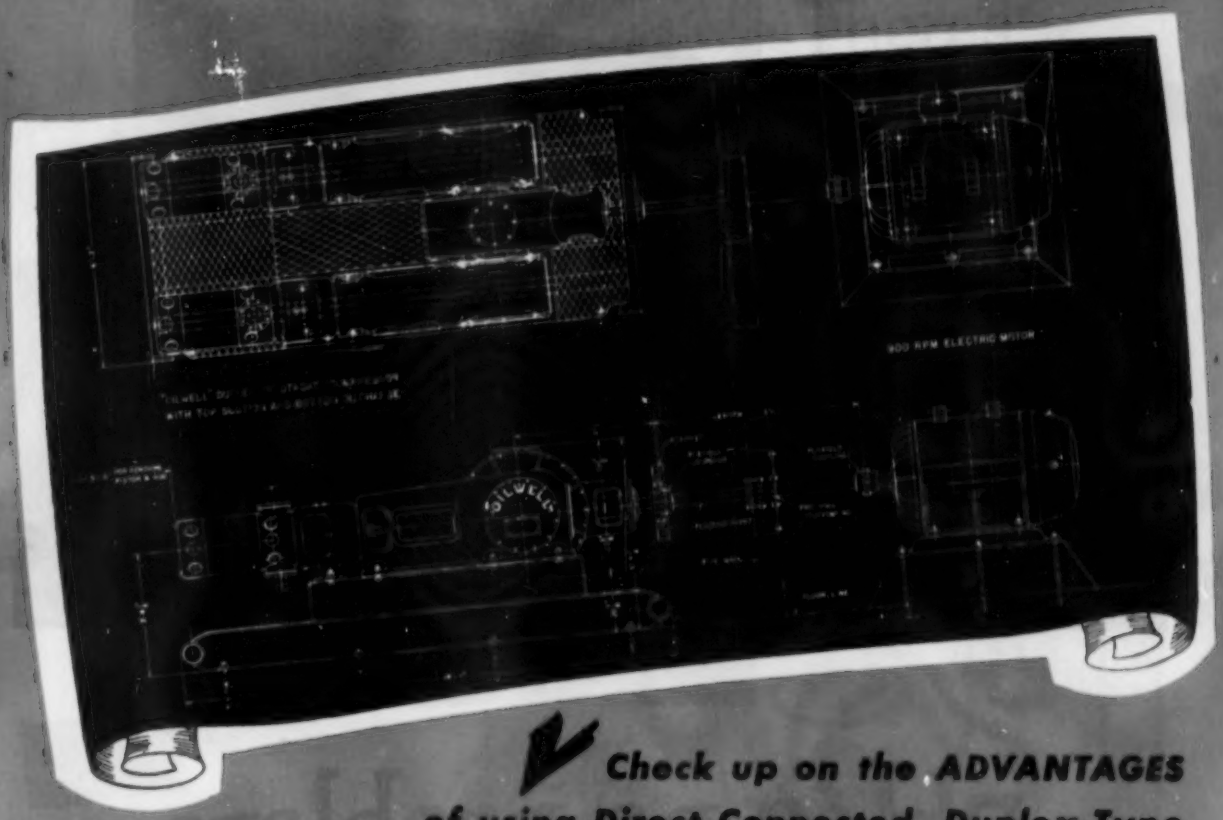

Check up on the ADVANTAGES of using Direct-Connected, Duplex-Type

"Oilwell" Compressor Units

. . . for Gas Compression in Refineries

"OILWELL" UNITS of this type are slow speed; designed with direct drive through right-angle gears to two parallel compressors so as to utilize 300 hp. input from a single prime mover with maximum efficiency.

For applications in the larger-volume-low-pressure range, single-stage compressors can be furnished. Where higher pressures are required, multi-stage compressors can be furnished to develop discharge pressures to 3,000 p.s.i.

Installations in hazardous areas can be made with maximum safety, by incorporating a fire wall between unit and driver as indicated in the sketch.

Where gas concentrating operations exceed the capacity of a single compressor unit, multi-unit installations are highly practical because they permit the routine servicing of individual compressors when necessary without shutting down the entire operation.

Let your "Oilwell" Representative . . . quote on "Oilwell" Compressor Units to meet the gas-concentrating requirements of your refinery.

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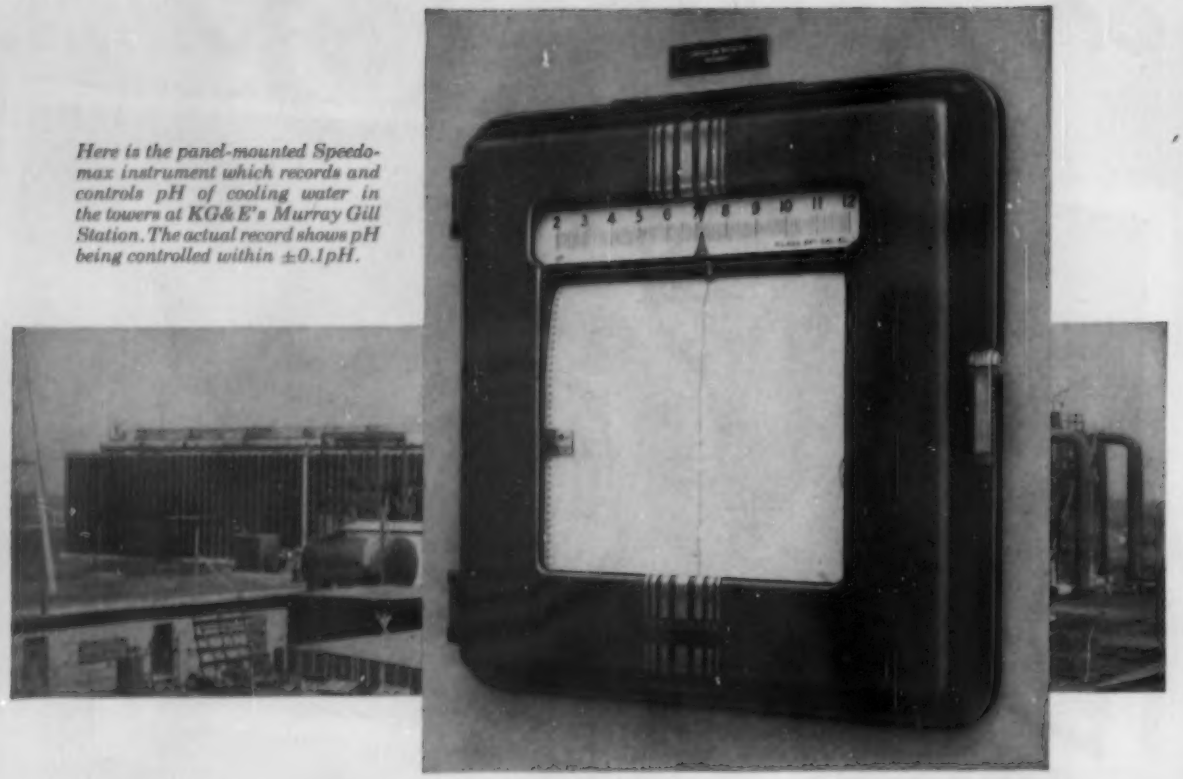
Here is the panel-mounted Speedomax instrument which records and controls pH of cooling water in the towers at KG&E's Murray Gill Station. The actual record shows pH being controlled within ±0.1pH.



pH is no problem

IN THIS COOLING TOWER

The once troublesome problem of effectively controlling the pH of cooling tower water has been solved in the towers at the Murray Gill and Ripley Stations of Kansas Gas and Electric Company.

Various other control arrangements, on similar tower systems, have been tried . . . with varying degrees of success. But the present system at KG&E demonstrates that, with the application of L&N's Controllability Analysis and practical engineering principles, a cooling tower system can work *for*, rather than *against*, full-function control of pH.

The benefits of effective pH control are readily apparent at KG&E. According to a report from the company's Production Department, they include "conserving large amounts of make-up water, wood protection, prevention of carbonate scale, and more effective slime control." The report adds that "automatic pH control at both plants has been effective and satisfactory."

We'll be glad to discuss your cooling tower pH control questions with you. Write for Process Data Sheet 700(1) which explains "L&N pH Control of Cooling Tower Water." With it, you'll receive a Controllability Analysis Questionnaire which will help us to analyze the controllability factors of your towers. Fill out the Questionnaire and return it, without obligation, to Leeds & Northrup Co., 4923 Stenton Ave., Philadelphia 44, Pa.

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instruments *automatic controls* • *furnaces*

For more data on advertised products, use Readers' Service Cards, last page.

powerstat

variable transformers

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This month's report is on:

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DM	4-6% Cr.-Mo.	18-8 Stainless	35-15**
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	16-25-6**

**Available as seamless tubing on an experimental basis only.*
***Not available as seamless tubing.*

THERE are probably several high temperature tube steels that will solve your heat, pressure, corrosion and oxidation problems. But there's only one analysis that will give you maximum tube life per dollar.

To find it, *ask the experts!*

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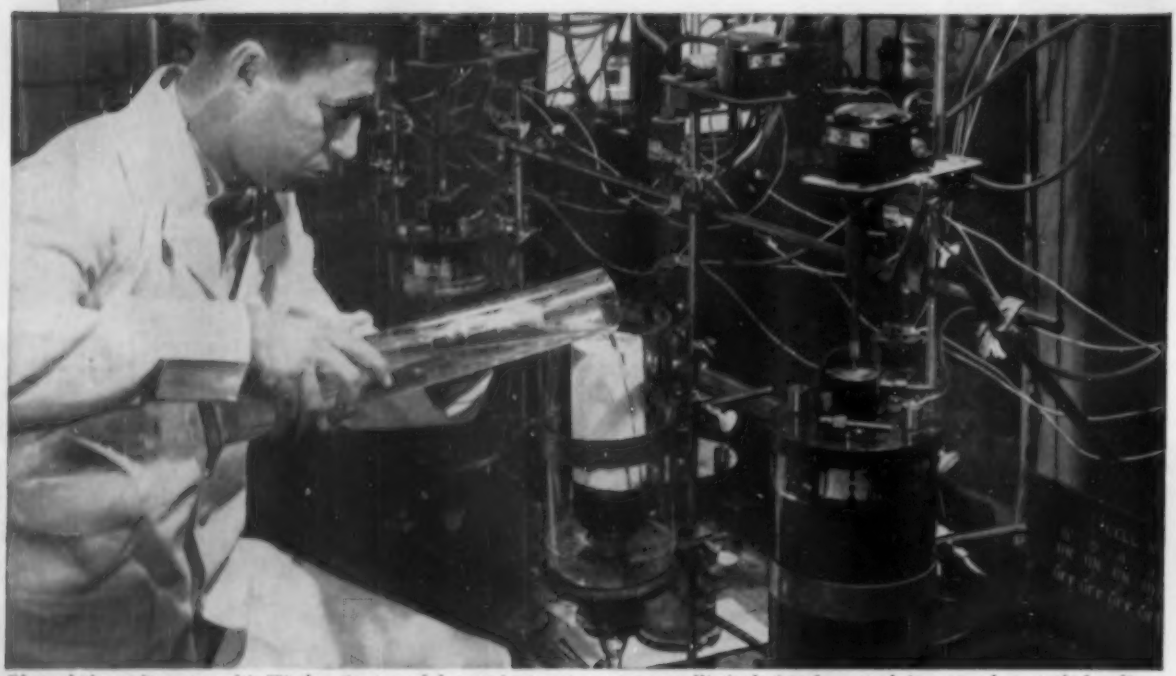
Let the Timken Company's RSQ—Research, Supply, Quality—solve your tube problems. *Ask the experts!* The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".



Electrolytic equipment used in Timken Company laboratories to extract non-metallic inclusions from steels in research on steel cleanliness

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

3600-rpm explosion-proof motor with fan housing removed to show unidirectional fan.

These heat exchanger tubes

Protect this motor from dirt and corrosion

COOLING AIR is carried through the heat exchanger tubes with sufficient velocity to expel practically all kinds of dirt. If oily or sticky dirt should cling, tubes can be ramrodded clean on the spot in a few minutes because tubes are straight and tube ends are exposed. Also, the tubes are distributed uniformly around the perimeter of the stator yoke and along its full length — cooling all parts of the motor evenly.

Choice of Corrosion-resistant Materials

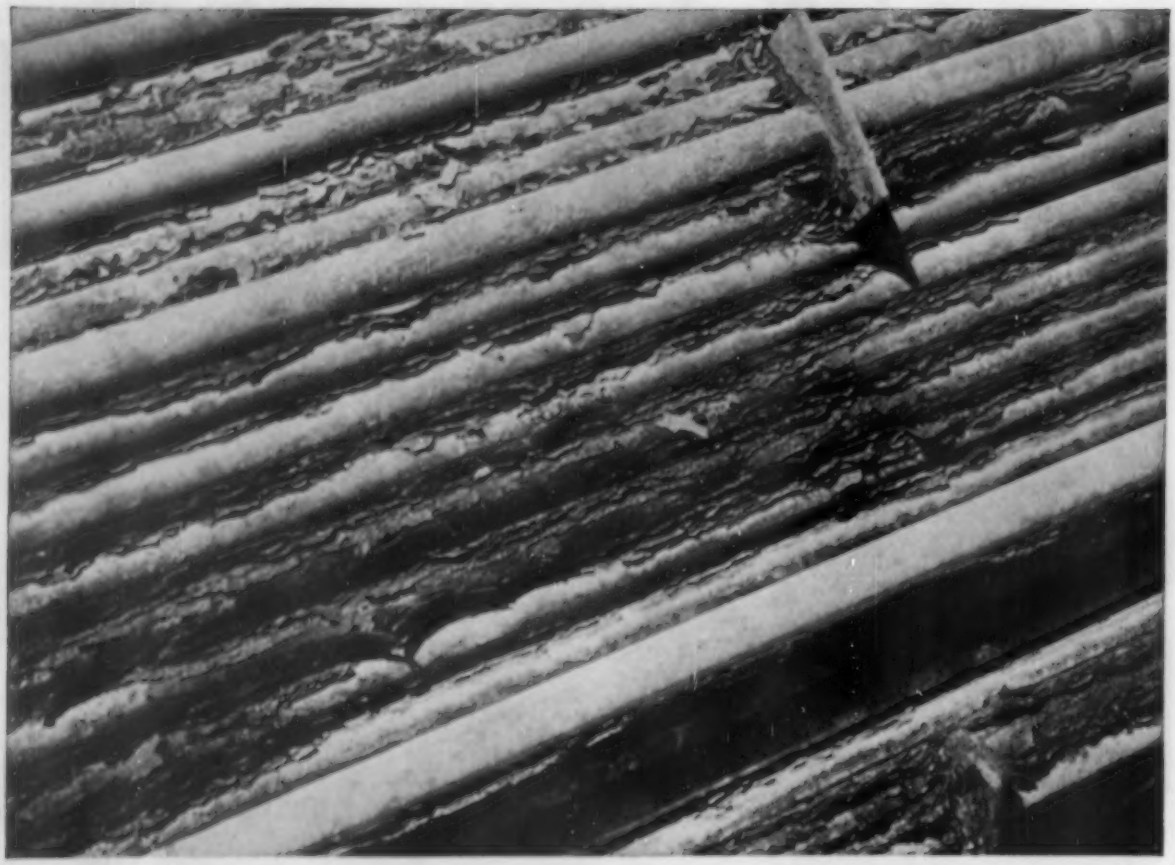
You can lick corrosion with this motor, too. Tubes are available in a variety of materials to meet practically any corrosive atmospheric condition. Allis-Chalmers tube-type motors have long and successful experience in such difficult applications as caustic plants, refineries and petrochemical plants, power plants with fly ash problems and many others.

Get Complete Information

Next time you need a motor for a dirty or corrosive location or for outdoor operation in all kinds of weather, call your Allis-Chalmers District Office. Get complete information on Allis-Chalmers tube-type totally-enclosed, fan-cooled and explosion-proof motors. Or write Allis-Chalmers, Milwaukee 1, Wisconsin, for Bulletin 51B7149. Available in ratings on frames larger than NEMA 505 up to 3000 hp (labelled through 1250 hp, 1800 rpm).

A-4550

ALLIS-CHALMERS



WHY PAY FOR THIS?

Why pay for fouling when Polyrad costs so little? Frequent down time for cleaning or replacing fouled and corroded equipment is no longer a normal operating expense for refineries. Not when Polyrad corrosion inhibitor can prevent damage with an average treatment of about 1 quart of Polyrad per 1,000 barrels of fluid.

Polyrad's powerful detergent action loosens organic and inorganic deposits and permits their removal in the fluid stream. This means you can prevent fouling by using Polyrad—and you can even clean up fouled equipment by starting Polyrad treatment. All around the refinery, Polyrad helps maintain throughput, increases heat transfer, reduces metal loss, and cuts down time for maintenance.

Polyrad is readily available from stocks maintained throughout the country. A Hercules technical representative will be glad to assist in evaluating Polyrad under your own operating conditions.

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HERCULES POWDER COMPANY
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POLYRAD®
FILMING AMINE INHIBITOR

NA55-2

Improve Heat Transfer ...Reduce Maintenance

by Eliminating Corrosion

Even when an efficient deaerator removes free carbon dioxide from your system, additional CO_2 produced by decomposition of bicarbonates and carbonates remains to cause return line corrosion. Residual oxygen causes pitting. Protecting against both CO_2 and O_2 considerably reduces the cost of replacing and maintaining steam and return lines. Keeping the system free of corrosion products assures high heat transfer efficiency.

One series of Allis-Chalmers corrosion inhibitors solves this problem by neutralization. These materials are blends of the most effective amines selected according to the volatility characteristics required by each steam condensate system. Protection is provided against both CO_2 and O_2 at the points where it is needed.

Although recommendations for your specific needs can be made only after thorough analysis, you can get more information about use of this series by obtaining a copy of Allis-Chalmers Water Conditioning Informational Bulletin 50. Get a copy from your nearby A-C office or write Allis-Chalmers, Milwaukee 1, Wisconsin.

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For more data on advertised products, use Readers' Service Cards, last page.

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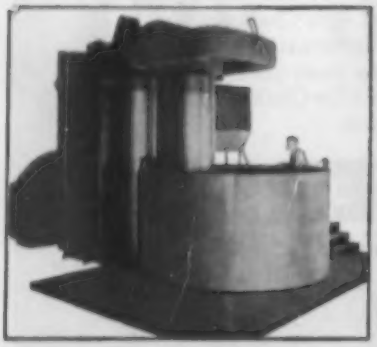
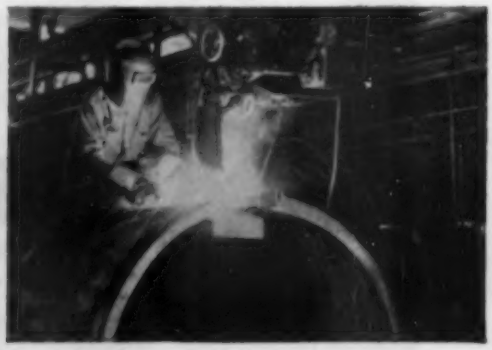
Uncompromising attention to detail during every manufacturing operation is the user's guarantee of satisfaction with B&W Process Equipment.

Many of the advanced production and testing techniques used, in casting, forming, machining, welding and stress relieving, require specially designed equipment. Much of this equipment was originally developed by B&W.

Intensive research and development, aided by long experience and first-rate facilities, have earned for B&W Process Equipment a fine reputation across the nation and abroad. The Babcock & Wilcox Company, Process Equipment Dept., Barberton, Ohio.





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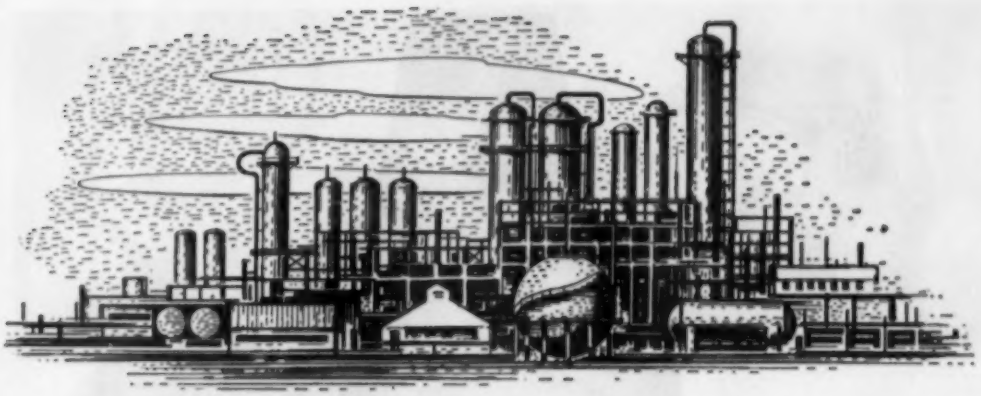
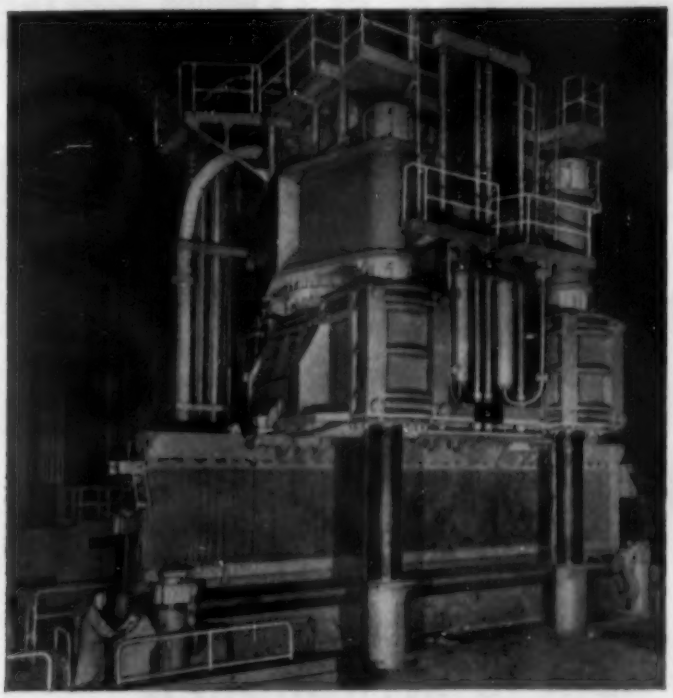


built to last



New hydraulic press, installed at B&W's Barberton, Ohio, works, is used to form extra heavy plate and to pierce billets. It is the largest of its kind, and has a capacity of 6500 tons plus.

BABCOCK & WILCOX

S-415

For more data on advertised products, use Readers' Service Cards, last page.

There are Qualities *Behind* ANNIN VALVES you'll never find in imitations

ANNIN DEVELOPED AND INTRODUCED:

SPLIT BODY

The Annin split-body design has given Industry new standards in control valve construction: lower body pressure loss, greatly reduced erosion, greater rangeability, longer life and reduced maintenance.

DOMOTOR OPERATOR

Out-performs all other pneumatic valve actuators. They are the highest speed, most powerful, and provide the best response characteristics. Long strokes assure that all size valves are truly hi-lift control valves.

TEFLON SEAT SEAL

The teflon seat seal for absolute tight closure, teflon guide bushing to eliminate guide clearance, and teflon V-ring packing for reliable stuffing-box performance were developed and introduced by Annin.

DOOLSEAL

Providing a new high in stuffing-box practice, the Doolseal, originally developed and introduced by Annin, assures reliable seal for hard-to-handle or toxic chemicals without resorting to mechanical seals.

...and many others!

CUT INVENTORY **50%** WITH

ANNIN
Control VALVES

THE ANNIN COMPANY
6570 East Telegraph Road
Los Angeles 22, California

For more data on advertised products, use Readers' Service Cards, last page.

ANHYDROUS AMMONIA... 250 tons per day

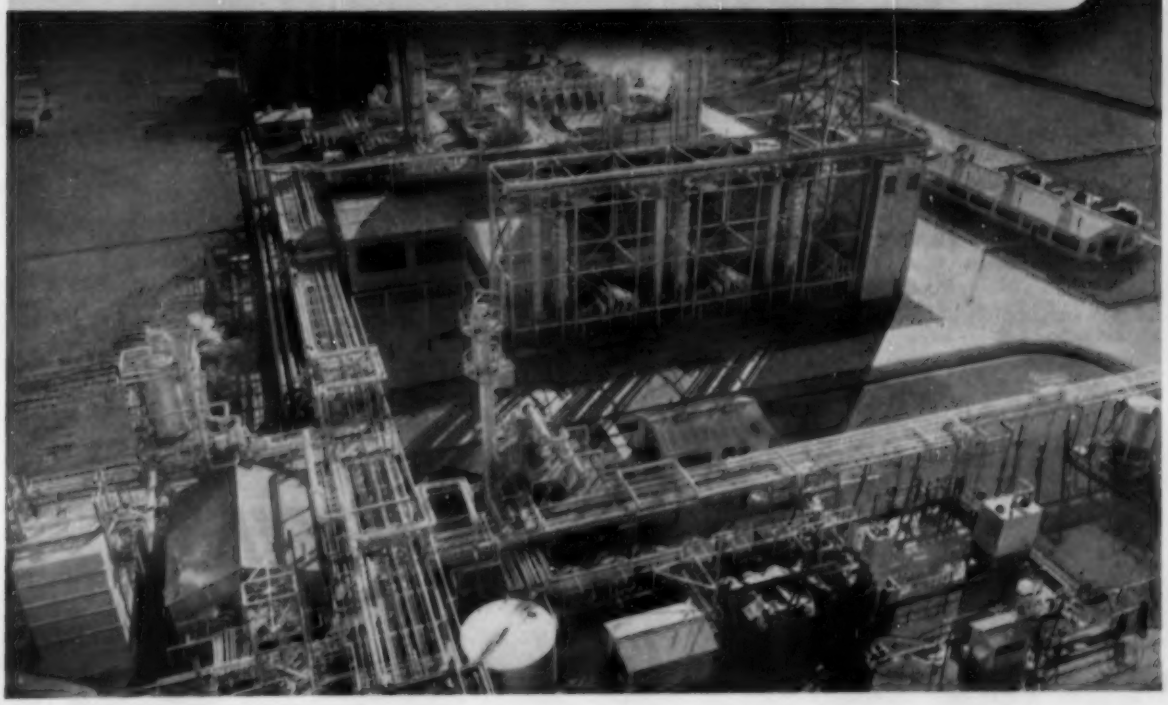
by the exclusive FW sequence

Another Ammonia Synthesis Plant by Foster Wheeler now on stream at Grace Chemical Company

Designed and built by Foster Wheeler, this modern Grace Chemical Co. plant at Memphis, Tenn. has a capacity of 250 tons of anhydrous ammonia per day.

It is another outstanding example of the proved economy and dependability of the FW Sequence — Texaco partial oxidation, FW liquid nitrogen wash and Casale ammonia synthesis. Write for the March-April issue of Heat Engineering, containing the complete story. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FOSTER WHEELER



For more data on advertised products, use Readers' Service Cards, last page.

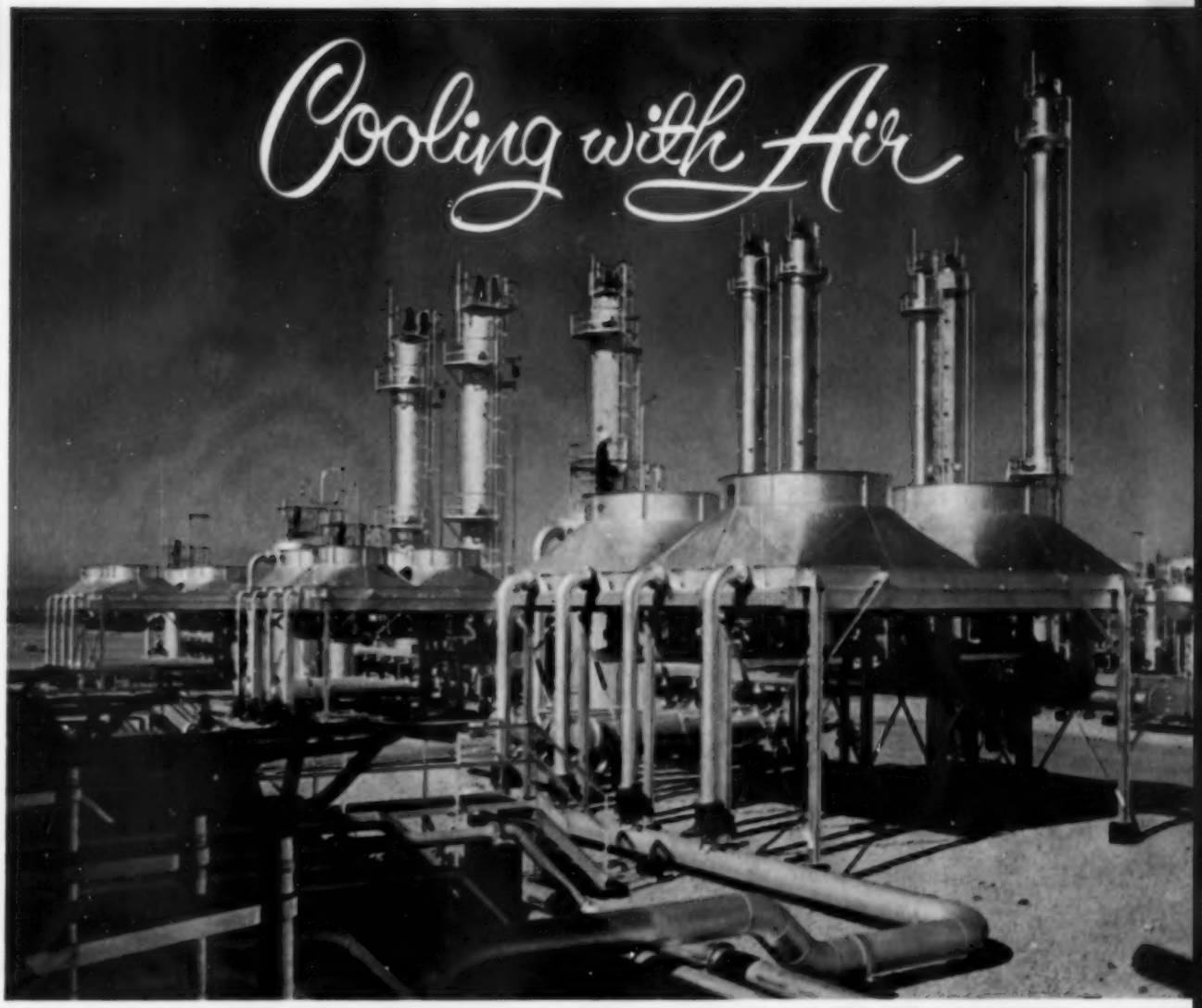
But . . . you know what it *also* takes to do a tough course in less than par. It takes skill, coordination, and experience in solving unusual problems—just as in prefabricating and installing high-pressure and high-temperature piping, the specialized field in which Mitchell service has proved so satisfactory to many top power and process plants. Ask us in.

W. K. MITCHELL & CO., INC.
2946 Ellsworth Street, PHILADELPHIA 46, PA.

WESTPORT JOINT
(PATENTED)

MITCHELL PIPING
SINCE 1899

PIPING FABRICATORS AND CONTRACTORS



HUDSON **SOLO-AIRE** units as pictured above are employed for dissipation of heat directly to air in rapidly expanding diversification of services. Almost every modern chemical plant, gas processing plant, or oil refinery, has cooling problems for which engineering comparisons dictate the use of Solo-aires for one or more services.

In water-scarce locations the choice of Solo-aires is obvious. Even where water is plentiful, careful comparisons of capital expenditures for cooling tower, piping, valving, water pumps, hot fluid to water exchangers, and costs of water treating, power and maintenance may result in selection of Solo-aires for direct cooling with air.

Where summer ambient air temperatures are too high to effect the required cooling with direct use of air, the HUDSON **COMBIN-AIRE**, in which air is first pre-cooled during warm weather, allows the advantages of air cooling with none of the disadvantages of ordinary cooling towers. Combin-aires are now constructed of fireproof materials, and as water spray is completely eliminated, they may be installed adjacent to process equipment.

Before proceeding with final design of process plant cooling systems let HUDSON assist you in making completely objective comparisons of water versus air cooling for all services.

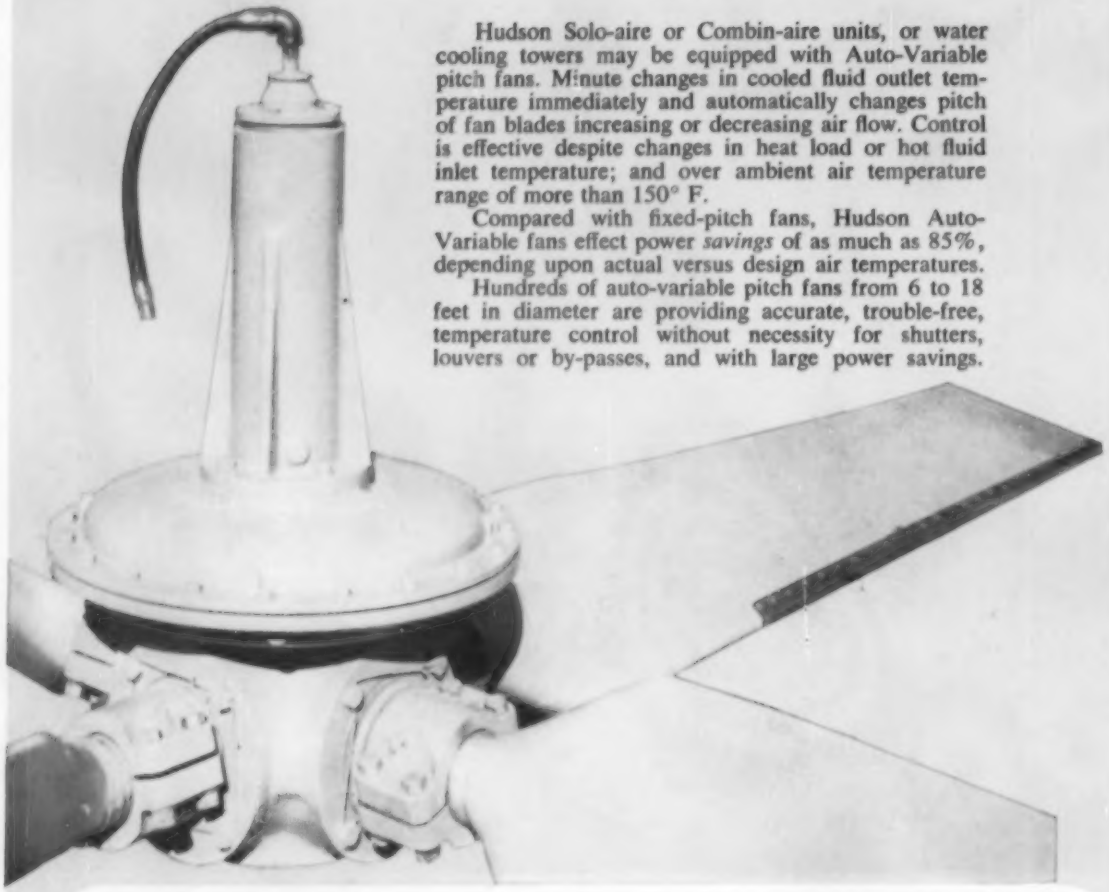
New

Air cooled equipment bulletin mailed upon request

HUDSON
ENGINEERING CORPORATION

FAIRVIEW STATION • HOUSTON, TEXAS

Accurate, Automatic Temperature Control



Hudson Solo-aire or Combin-aire units, or water cooling towers may be equipped with Auto-Variable pitch fans. Minute changes in cooled fluid outlet temperature immediately and automatically changes pitch of fan blades increasing or decreasing air flow. Control is effective despite changes in heat load or hot fluid inlet temperature; and over ambient air temperature range of more than 150° F.

Compared with fixed-pitch fans, Hudson Auto-Variable fans effect power *savings* of as much as 85%, depending upon actual versus design air temperatures.

Hundreds of auto-variable pitch fans from 6 to 18 feet in diameter are providing accurate, trouble-free, temperature control without necessity for shutters, louvers or by-passes, and with large power savings.

HUDSON AUTO-VARIABLE PITCH FANS

- **Accurately control temperature.**
- **Effect major savings in power.**
- **Reduce cost of control equipment.**
- **Eliminate by-pass piping.**
- **Prevent freezing even in extremely cold weather.**
- **Operate with standard pneumatic instruments.**
- **Have all moving parts of control mechanism completely enclosed and weather-proofed.**

Hudson designs and manufactures cooling systems using water exclusively, air exclusively, and combinations of air and water. Objective comparisons are furnished without cost.

Hudson Auto-Variable Pitch Fan is protected by U. S. patents and patents pending.

HUDSON
ENGINEERING CORPORATION

FAIRVIEW STATION • HOUSTON, TEXAS

For better fluidizing

Aerocat®

fluid cracking catalyst

offers your choice of **PDI***

To give you better fluidizing, circulation and attrition characteristics in *your* cracking unit, AEROCAT Fluid-Cracking Catalyst is offered in a range of grades — Light, Intermediate and Narrow. The particle size distribution of each grade is designed for optimum performance in any of the various types of units operating today. Look for the PDI in the name, and specify *better performance* by specifying AEROCAT.

*PDI—Particle Distribution Index—
your key to catalyst efficiency.

AEROCAT 50/60 Fluid Cracking Catalyst (Light)

AEROCAT 60/70 Fluid Cracking Catalyst (Intermediate)

AEROCAT 75/85 Fluid Cracking Catalyst (Narrow)

AMERICAN *Cyanamid* COMPANY
REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N. Y.

In Canada: North American Cyanamid Limited, Toronto and Montreal

SNAP*ON...

the modern, efficient way to insulate pipe

Take a good look at the unique one-piece glass fiber pipe insulation that insulates a 6-foot section of pipe as quick as you can say "Snap*On!" Then picture the savings in your plant when you put Snap*On on large or small, hot or chilled piping.

These on-the-job photos were taken at a midwestern university where large steam distribution lines in tunnels were recently insulated with Snap*On. The job was done in remarkably short time because of the exceptional ease of application. Workmen were pleased to discover that Snap*On weighed only 1/10 to 1/4 as much as conventional insulations — yet was so fibrous-tough that there was no breakage . . . no mess . . . no clean-up time.

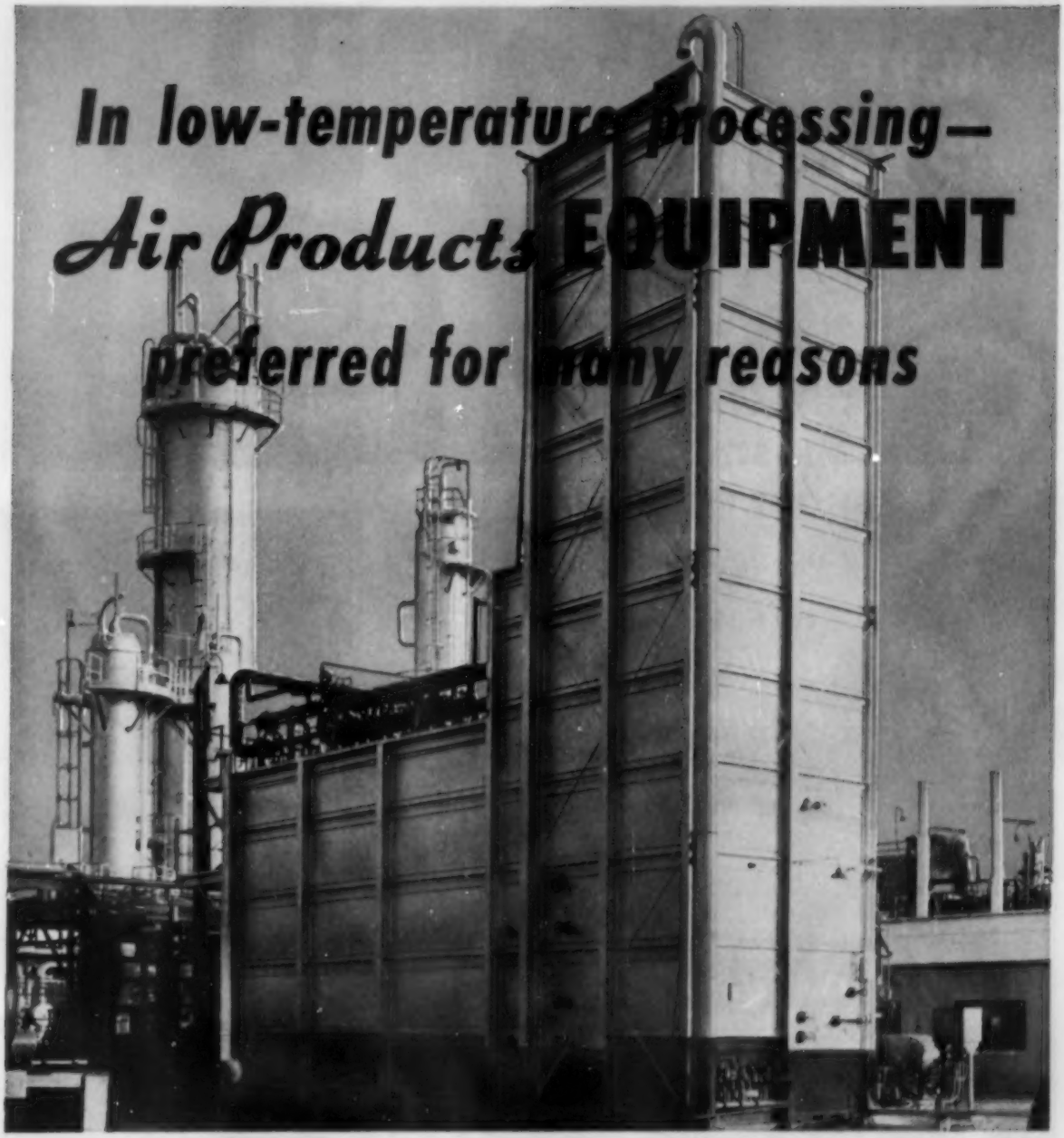
An important secondary saving was the heat saving. Tests conducted on the finished job by the university showed the surface temperature of Snap*On to be 50° lower than that recorded on the insulation formerly used!

These are documented facts. The same sort of superior thermal efficiency and low-cost application can be yours if you insulate piping up to 33" in diameter, where temperatures do not exceed 350°. But see for yourself — write today for samples and Technical Bulletin SO-55 today.

GUSTIN-BACON *Manufacturing Company* GUSTIN gb BACON

Thermal and acoustical insulations • Molded glass fiber pipe insulation • Pipe coverings and fittings

242 W. 10TH ST., KANSAS CITY, MO.



There are more than 700 reasons for the strong preference indicated for Air Products units in low-temperature processing. That is the number of gas separation plants designed and constructed by this company since it was founded—a truly remarkable record confirming the general satisfaction with Air Products performance.

The know-how gained in this extensive experience by our more than 100 full-time engineers is available to you. If your company is one of those wishing to explore the profitable possibilities in the purification of refinery gas, coke oven gas, natural gas, or any hydrocarbon-rich stream—take it up with Air Products. Let us investigate the potential yield of hydrogen and hydrocarbons for you. We will furnish a preliminary engineering analysis, or a complete process design. Provide us with an outline of your problem—it will involve no obligation on your part.

36-page Brochure explores the broad possibilities of low-temperature processing . . . illustrates Air Products facilities. Write for a free copy.

Air Products
INCORPORATED
Dept. X, Box 538, Allentown, Pa.
Specialists in Low-Temperature Processing

Cost Analyses • Process Design • Apparatus Design • Apparatus Manufacture

There's No Denying These Facts...

MORE THAN 1250 PETROCHEM-ISOFLOW FURNACE INSTALLATIONS THROUGHOUT THE WORLD

In Plants of Modern Design

PROVE THIS FURNACE

Most Efficient By Any Comparison

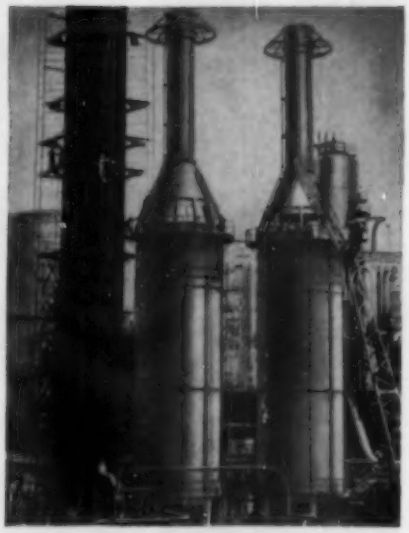
. . . for refiners using catalytic processes including cracking, reforming, alkylation, polymerization, isomerization, desulfurization, hydrogenation and dehydrogenation

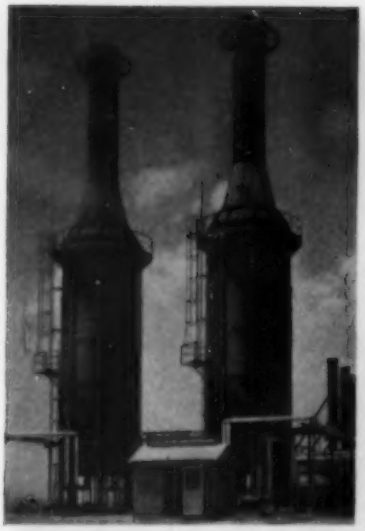
PETROCHEM-ISOFLOW FURNACES are Unlimited in Size . . . Capacity . . . Duty from 100,000 to 250,000,000 BTU PER HOUR

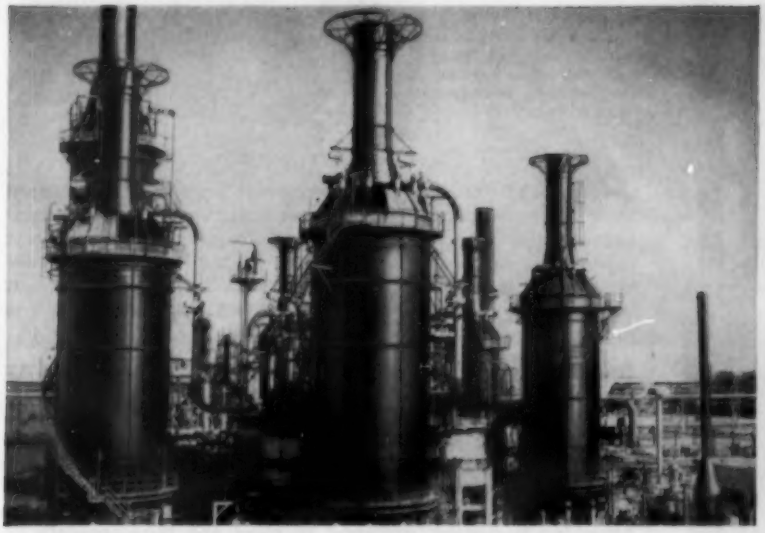
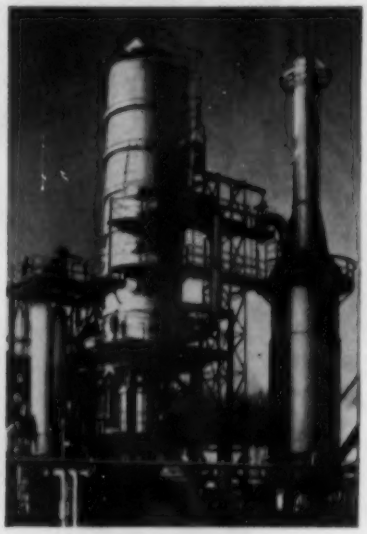
These are the 11 all-important factors which determine the value and efficiency of processing furnaces:

UNIFORM HEAT DISTRIBUTION
MAXIMUM FUEL EFFICIENCY
PLENUM CHAMBERS FOR HAZARDOUS AREAS
SIMPLICITY OF DESIGN AND CONSTRUCTION
EXCESS DRAFT FOR HIGH OVERLOAD
EXPLOSION RESISTANT
MINIMUM GROUND SPACE
SHORT LENGTH OF LIQUID TRAVEL
ZERO AIR LEAKAGE
LOW PRESSURE DROP
LOW MAINTENANCE

In every one where these 11 all-important design characteristics were employed to compare one type of furnace design with another, PETROCHEM-ISOFLOW FURNACES were proved most efficient by any comparison.





PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE ... CAPACITY ... DUTY

PETRO-CHEM DEVELOPMENT CO., INC. • 122 East 42nd St., New York 17, N. Y.

Representatives: Bethlehem Supply, Tulsa and Houston • Flagg, Brackett & Durgin, Boston • D. D. Foster, Pittsburgh • Fovillo-Levally, Chicago • Lester Oberholtz, Los Angeles • Gordon B. Hardin, Louisville • Turbex, Philadelphia (Norberth, Pa.)

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For more data on advertised products, use Readers' Service Cards, last page.

Oil Immersed

mechanically interlocked power outlet

Type 620-A-3GX Safety Switch with Receptacle and Plug Interlock—Closed view and with oil tank lowered showing arrangement of component Parts.

A SAFETY POWER outlet to provide dependable operation under adverse conditions and convenience for readily connecting portable equipment such as welding machinery, conveyors, mixers, agitators, etc. Manually operated, mechanically interlocked switch handle and plug makes it impossible to insert or remove the plug while the switch is in the closed position.

Standard features of the Rowan Type 620-A-3GX Safety Switch include the following: completely oil immersed; manually operated disconnect switch of the quick-acting contactor type with renewable contacts; equipped with ROWAN time-tested AIR-SEAL fuses; sealed-off terminal compartment; safety disconnect jack; straight through conduit entrance; provision for padlocking switch in the OFF position; enclosure designed to meet the requirements of NEMA Type XI—also available for NEMA Type VIII, Class 1, Group D locations, designated Type 620-A-1-3GX.

Complete information available from Rowan representatives in principal cities of the United States.

ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.

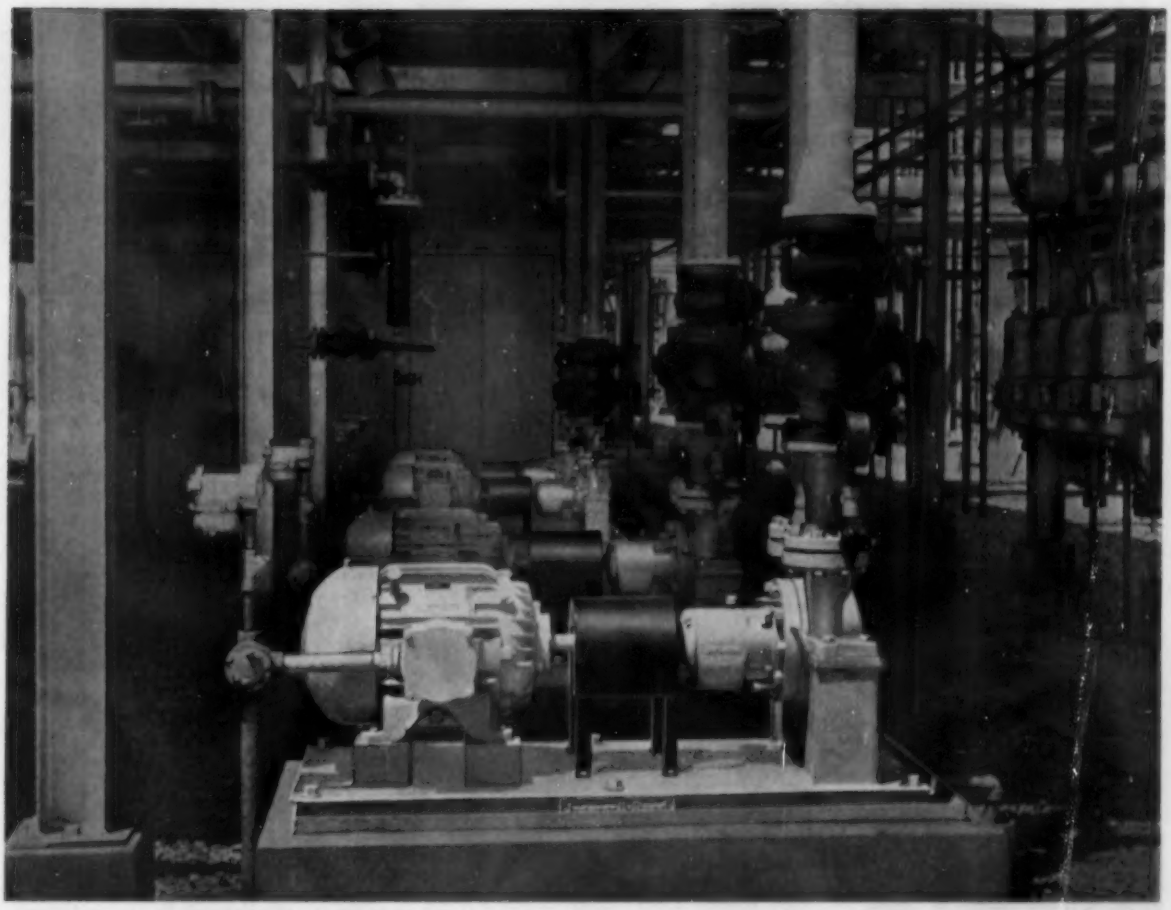

Photo by E. M. Payne

for debutanizer reflux at AMBROSE GASOLINE PLANT . . .

Ingersoll-Rand SFLA Pumps were selected by Hudson Engineering Corp., designers and builders of this new plant for Cities Service Oil Co. In fact, these newest design process pumps – with integral mechanical shaft seals that eliminate stuffing box maintenance – serve on all reflux services at this Blackwell, Oklahoma plant, now processing 155 million cfd of 565 psia natural gas from the Hugoton field. The units shown handle 136 F. debutanizer reflux at 134 psig discharge.

Other Ingersoll-Rand pumps at this plant are on lean oil, boiler feed, water circulation and loading services. Three Ingersoll-Rand 8-cylinder gas engines provide 900 kw of electric power for plant use.

Your liquid moving problems can be best solved by I-R process pumps. There's a branch office near you that will be glad to give you more information.

Ingersoll-Rand

Cameron Pump Division
11 Broadway, New York 4, N. Y.

10-10

PUMPS • COMPRESSORS • TURBO-BLOWERS • VACUUM EQUIPMENT • AIR & ELECTRIC TOOLS • GAS & DIESEL ENGINES

For more data on advertised products, use Readers' Service Cards, last page.

THE MEN BEHIND TRECO

TRECO

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President

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Process Engineer

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Vice President

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Project Engineer

P. M. SOWERS
Director of Purchases

K. T. WALKER
Chief Engineer

You've probably met one or more of these men in your contacts in the refinery industry. They've done just about every job in refineries prior to their engineering-construction careers.

When a plant is designed by these men and their associates, you know it will produce as planned. You can rest assured that not even the smallest detail will be overlooked and that it will be completed on time.

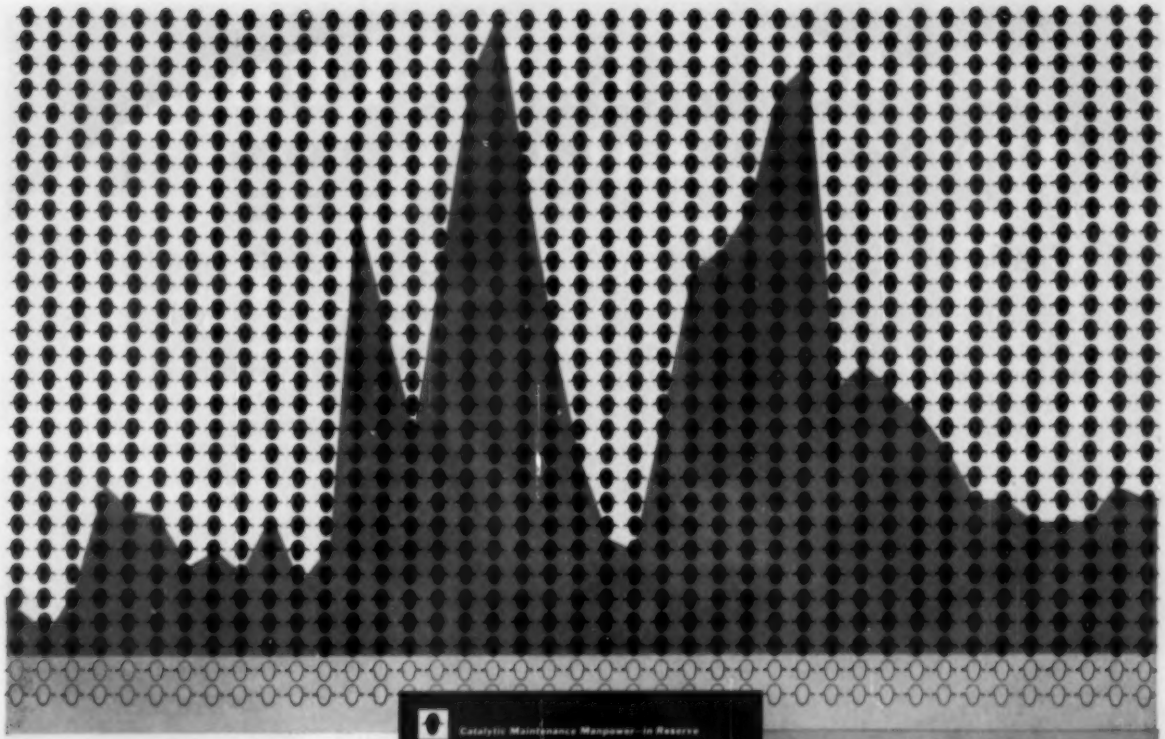
Whether you require a new refinery or to revamp existing facilities, it will pay you to talk with TRECO before you make any plans. TRECO has the man power, the equipment and company aircraft to complete your job *FAST*.

In Canada — 2 Toronto Street, Toronto, Ontario

TRECO

REFINERY ENGINEERING Company

TULSA TORONTO



HOW HIGH IS your MAINTENANCE COST ?

This graph of the actual maintenance manpower load of an operating refinery demonstrates the value of *Catalytic's Maintenance Contract Service.*

Catalytic supplies experienced men, willing and able to do a *good day's work—as required* and *on time*—for normal operation, emergency or planned shutdown.

Our flexible service eliminates costly "made work" which often results from unavoidable valleys of maintenance requirements. Whatever the circumstances, Catalytic adds skilled supervision and manpower plus equipment—and works *as a team* with your regular crew.

The value of our service has consistently won repeat contracts. We suggest that you investigate the application and advantages of this plan to your operation—with an eye to higher productivity and lower maintenance cost.

CATALYTIC
CONSTRUCTION COMPANY
1528 Walnut Street, Philadelphia 2, Pennsylvania

In Canada:
Catalytic Construction of Canada, Ltd.; Sarnia, Ontario

CATALYTIC ON-TIME . . . ON-BUDGET SERVICES for the atomic energy, chemical, petrochemical and oil refining industries · Project Analysis · Process Design · Economic Studies · Engineering · Procurement · Construction · Plant Operation

For more data on advertised products, use Readers' Service Cards, last page.

WIGGINS DOUBLE PONTOON FLOATING ROOFS

Safest Storage for Your "Liquid Assets"

Performance records prove that Wiggins Double Pontoon Floating Roofs soon pay for themselves in liquid conserved. Only Wiggins Double Pontoon Floating Roofs have every important feature for maximum conservation . . . safest operation . . . low-cost maintenance.

Triple Seal increases conservation savings and adds extra safety.

Multiple gas-tight pontoon compartments increase safety, strength and buoyancy.

Simplified design gives strength with minimum trussing, making inspection and maintenance easy.

Complete, clean drainage reduces corrosion problems.

Get the full story on the General American-Wiggins system of petroleum liquid conservation by writing us on your letterhead for the new Wiggins Manual WP-14.

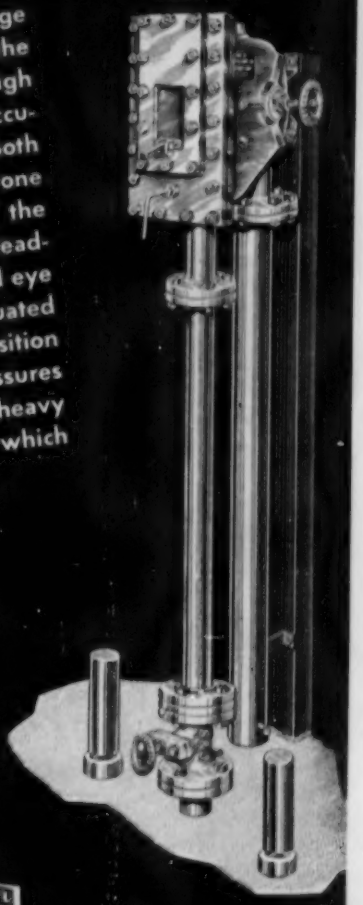
Wiggins Double Pontoon Floating Roofs, Dry Seal Gasholders, Lifter Roofs, Cone Roofs

GENERAL AMERICAN TRANSPORTATION CORPORATION

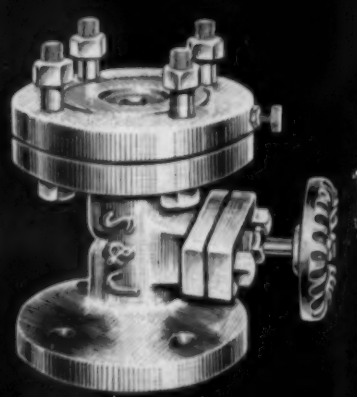
135 SOUTH LA SALLE STREET · CHICAGO 90, ILLINOIS

AUTOMATIC GAGES
for Pressure Storage

Since hand gaging of pressure storage vessels is impossible and gage glasses are frequently too inaccurate, automatic tank gaging is the only practical alternative. S. & J. engineers have designed two high pressure automatic tank gages which will consistently and accurately measure product depths in pressure storage vessels. Both gages are similar in operating principle but differ primarily in one important aspect—MOUNTING. Model ST-400 R, illustrated at the right, is designed for mounting on tank tops and for eye level reading. Model ST-400 is designed for ground level installation and eye level reading. In both gages, an 18-8 stainless steel tape, graduated to eighth inches, is affixed to a pressure type float, held in position by guide wires. Both types are available for operation at pressures up to 300 pounds. In both designs, the tape is read through heavy safety glass, which can be kept clear by an inside wiper, and which is protected against breaking by a special steel closure.



The S. & J. Tape Block Valve, Figure ST-5265, passes the reading tape through a heavy synthetic rubber tube. When it is desirable to isolate the gage head from tank pressure, the valve is screwed down to flatten the tube against the tape and provide complete isolation for inspection, maintenance or repair of the reading head.



S. & J. Automatic Tank Gages are available in a great variety of designs, from the most simple, to elaborate electric telepulse remote reading gages. Having pioneered automatic tank gaging, you can look to S. & J. to supply a SAFE and ACCURATE automatic tank gage for every requirement in the petroleum industry. Tell us of your requirements and we will gladly make recommendations covering any gaging problem.

Shand and Jurs Co.

BERKELEY 10, CALIFORNIA

NEW YORK
342 Madison Ave.

CHICAGO
10409 S. Western Ave.

HOUSTON
M & M Bldg.

TULSA
Thompson Bldg.

LOS ANGELES
714 W. Olympic Blvd.

REPRESENTATIVES:
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TORONTO: Lytle Engineering Specialties, Ltd., 85 Richmond St., W.
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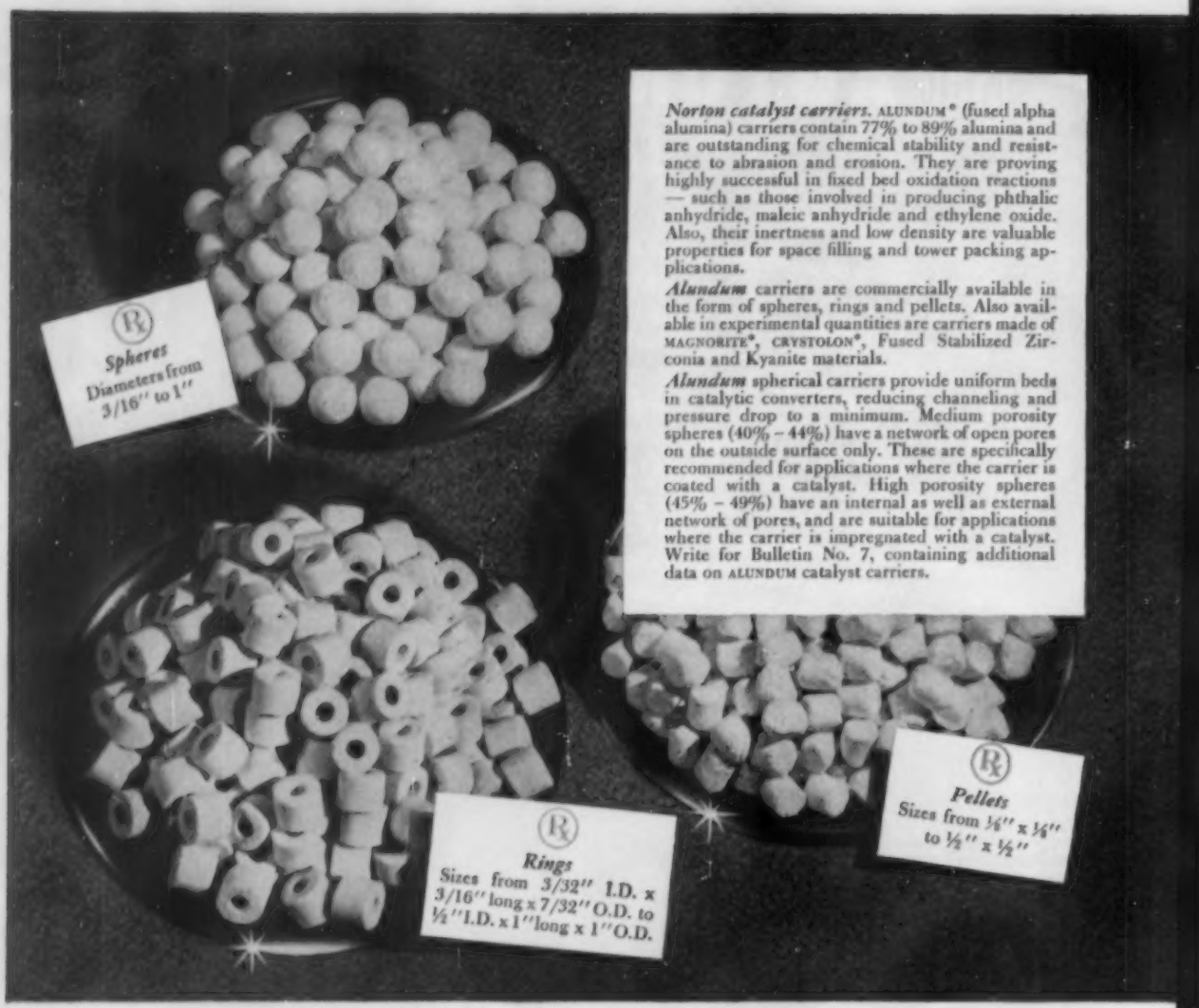
Whessoe, Ltd., Works: Darlington, County Durham

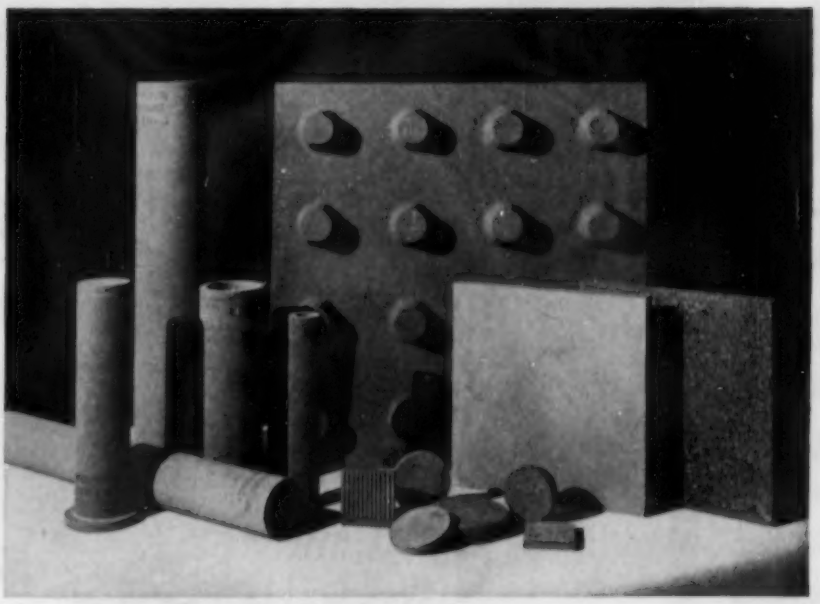

Rx
Spheres
Diameters from 3/16" to 1"
Rx
Rings
Sizes from 3/32" I.D. x 3/16" long x 7/32" O.D. to ½" I.D. x 1" long x 1" O.D.
Rx
Pellets
Sizes from ⅛" x ⅛" to ½" x ½"
Norton catalyst carriers. ALUNDUM* (fused alpha alumina) carriers contain 77% to 89% alumina and are outstanding for chemical stability and resistance to abrasion and erosion. They are proving highly successful in fixed bed oxidation reactions — such as those involved in producing phthalic anhydride, maleic anhydride and ethylene oxide. Also, their inertness and low density are valuable properties for space filling and tower packing applications.
Alundum carriers are commercially available in the form of spheres, rings and pellets. Also available in experimental quantities are carriers made of MAGNORITE*, CRYSTOLON*, Fused Stabilized Zirconia and Kyanite materials.
Alundum spherical carriers provide uniform beds in catalytic converters, reducing channeling and pressure drop to a minimum. Medium porosity spheres (40% – 44%) have a network of open pores on the outside surface only. These are specifically recommended for applications where the carrier is coated with a catalyst. High porosity spheres (45% – 49%) have an internal as well as external network of pores, and are suitable for applications where the carrier is impregnated with a catalyst. Write for Bulletin No. 7, containing additional data on ALUNDUM catalyst carriers.

Rx for more profitable processing

Norton engineered and prescribed refractories are proved aids to better, lower cost production

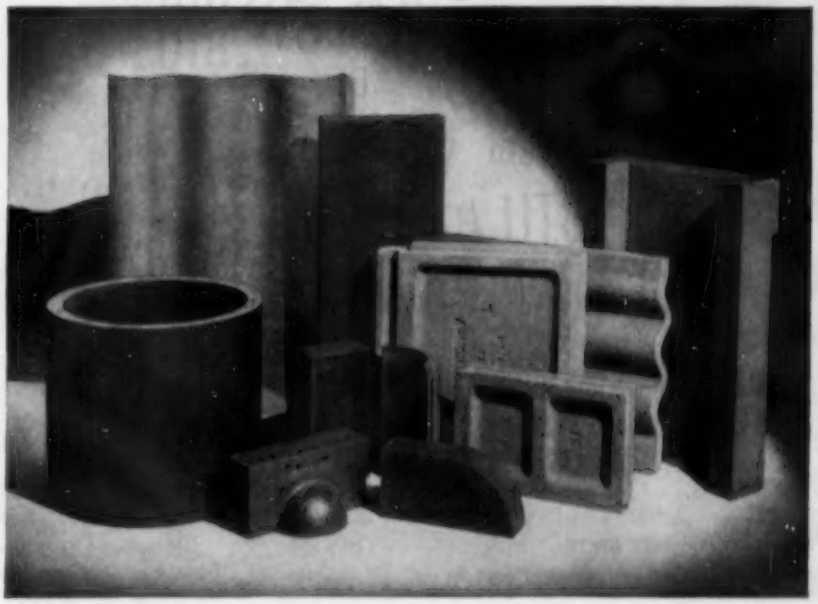
Backed by over 50 years of experience in electrochemical refining, Norton produces refractories whose purity and properties are carefully controlled and consistently duplicated. These refractories are *engineered and prescribed* to give you the best possible Rx — the most effective combination of physical characteristics, plus thermal, chemical and electrical properties — for your particular applications.

Chemical engineers are finding these Rx's of immense practical value in widely varying processes. Whatever your own processes may be, it will pay you to learn more about the many advantages of Norton refractories. Just a few products in this complete, top-quality line are described here. For complete details, and expert technical aid, call in your Norton Refractories Engineer. Meanwhile, write direct for the illustrated bulletins, mentioned in this advertisement, that cover your requirements. NORTON COMPANY, 464 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Can.



Norton porous mediums come in plates, tubes, discs and diaphragms, engineered to fit your filtering, diffusing or aerating requirements. All have uniform porosity, in the size and open-pore ratio you need. Made of ALUNDUM material that is chemically stable and strong, their resistance both to acid and alkaline conditions gives them extra long life. Norton seamless porous tubes have the advantage, unusual in tubes, of uniform porosity over their entire area — permitting constant air or liquid pressure and enabling uniform backwashing to do more thorough cleaning.

Typical applications are filtering water or solvents; cutting oils, wine and other liquids; reclaiming cleaning fluids; handling industrial oil wastes; chlorination, carbonation and other gas diffusion applications. Bulletin No. 140 tells you more about Norton ALUNDUM porous mediums.



Norton refractory shapes for reaction furnaces come in bricks, plates, tubes and blocks, made of ALUNDUM, CRYSTOLON, MAGNORITE and Fused Stabilized Zirconia refractory materials. The development of Fused Stabilized Zirconia is a typical example of how Norton aids you in utilizing higher temperatures for greater efficiency and output. Norton was the first to bring this valuable material out of the experimental stage into commercial production. Now it is used in many processes.

No other refractory is so chemically stable at such high temperatures under both oxidizing and reducing conditions. In gas synthetic processes, furnaces lined with it have withstood temperatures approaching 4700°F for long periods. Its low thermal conductivity (6.2 BTU in dense shapes at 2000°F) and its high electrical conductivity at high heat are other important properties, all of which are described in Bulletin No. 1741.

Norton electric furnace shapes and laboratory ware

Norton electric furnace refractories — cores, tubes and muffles — are made of ALUNDUM or CRYSTOLON materials. ALUNDUM shapes, composed of 99% pure fused alumina, are characterized by great stability, chemical inertness, excellent thermal conductivity and good electrical insulation qualities. CRYSTOLON shapes, for use under more limited conditions, combine high thermal conductivity with resistance to heat shock. Bulletin No. 458 tells how to construct electrical furnaces for the laboratory.

Norton ALUNDUM laboratory ware, available at your laboratory supply house, offers many properties important to development, experimental or analytical work. It is chemically stable, stands temperatures up to 1900°C and is easy to clean. For filtering, it comes in four degrees of permeability. Bulletin No. 793 gives you the whole story.

NORTON

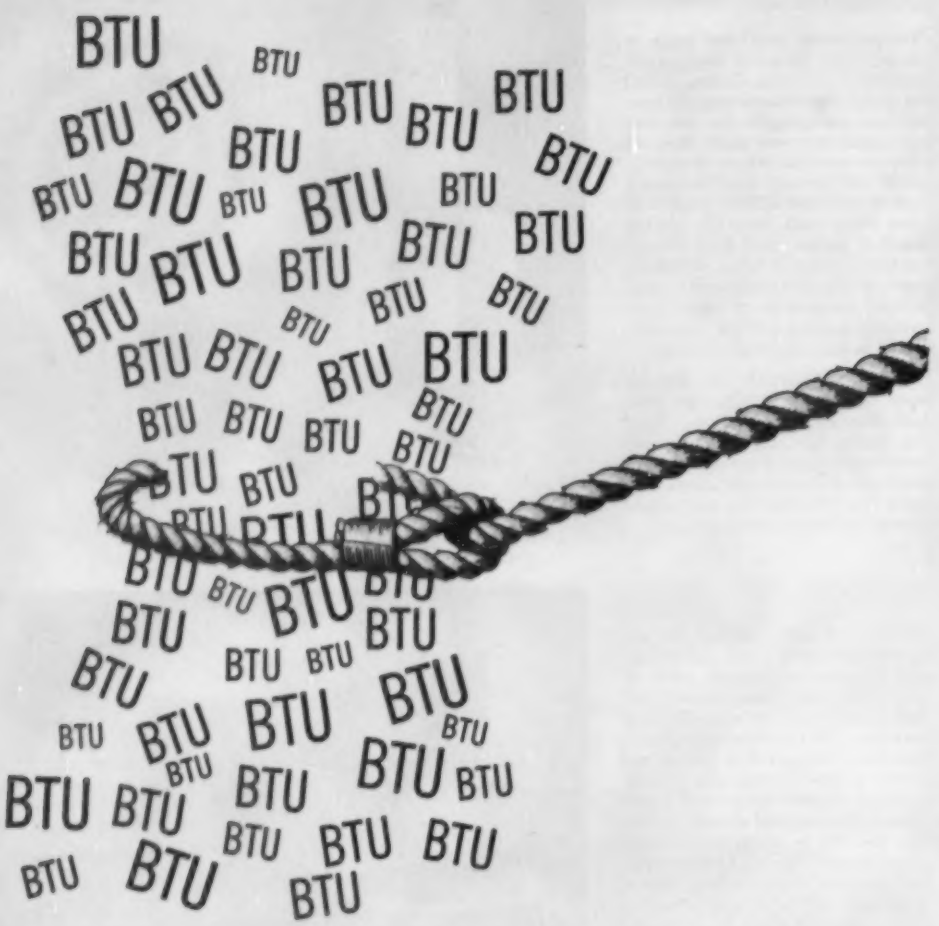
REFRACTORIES

Engineered . . . Rx . . . Prescribed

Making better products . . . to make your products better

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

For more data on advertised products, use Readers' Service Cards, last page.



cut fuel costs

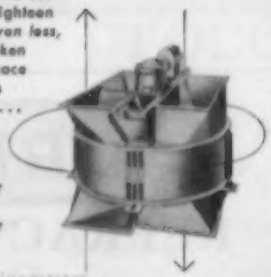
you can save one barrel in every five with the

Ljungstrom® Air Preheater

HOW FAST IS "WRITE OFF"?

In fuel savings alone, most refiners write off the cost of the Ljungstrom installation in twelve to eighteen months. This time is cut to *nine months and even less*, when the other Ljungstrom advantages are taken into account – permits more economical furnace design, with no need for convection surfaces . . . burns many fuels you used to throw away . . . results in consistently higher through-put . . . boosts product quality . . . and minimizes slag.

For more complete details on what the Ljungstrom Air Preheater can do for you . . . for an analysis of the heat-recovery benefits attainable in fuel burning equipment – call or write The Air Preheater Corporation.



Wherever You Burn Fuel, You Need Ljungstrom

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

How much fuel do your process units burn *just to keep the stacks hot?* It takes precious BTU's to keep them as hot as they are . . . BTU's that, if recaptured, would be working for you – instead of costing you money.

With the Ljungstrom, much waste heat is recovered from exit gases, transferred to incoming combustion air and funneled back into the furnace. How much fuel does this save? You get an idea when you consider that for every 45-50°F of preheat, your fuel bill drops 1% – and Ljungstrom Air Preheaters now in use preheat air to over 1,000°F.

That's why a Ljungstrom saves you up to 20% of your fuel costs – *one barrel in every five.* In fact, one midwestern refiner reports $74,200 saved in fuel in one year. And after he subtracted the Ljungstrom operating cost, he still wound up the year $64,800 ahead.

The Air Preheater Corporation **60 East 42nd Street, New York 17, N. Y.**

GENERAL REFRACTORIES

GAS AND OIL...FROM BRICK When you say: "Fill 'er up", you're putting brick to work. Refractory brick. For once crude oil is pumped from the well, every process in making petroleum products depends on heat that only refractory lined furnaces can handle.

Practically everything you buy or use, everything that's made or moved, is dependent on refractories. The steel in your car, the glass in your windshield, the rubber in your tires, and the "blacktop" of your drive.

When you consider the enormous variety of industry, and the infinity of processes, you get some inkling of the tremendous technology and scientific reservoir that General Refractories draws on to produce refractories of highest efficiency and utility for specialized needs.

Company-owned sources half a world away pour in materials, all subject to the most exacting analyses and tests in the world's finest refractories laboratory, where new and finer products are constantly evolving.

With 66 mines and manufacturing plants, strategically located sales offices and warehouses, Grefco truly provides a complete refractories service.

GENERAL REFRACTORIES COMPANY
PHILADELPHIA 2

A COMPLETE REFRACTORY SERVICE

LITECAST-50—A hydraulic setting light weight castable having a density of approximately 50 lbs. per cu. ft. Available in regular mix and pneumatic gun mix.

HIGH-STRENGTH BRIK-CAST—A hydraulic setting clay base castable having exceptionally high strength. Available in regular, pneumatic gun mix and trowel mix.

GREFCO CASTABLES are manufactured at 4 strategically located plants in Pennsylvania, Missouri, Texas, and California.

for catalog data on

JOHN ZINK

JZ

BURNERS

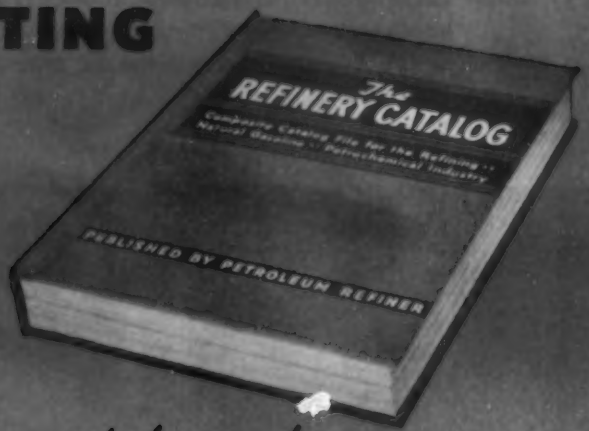
for

REFINING

PROCESSING

HEATING

GENERATING



See the complete line, pages 923-937

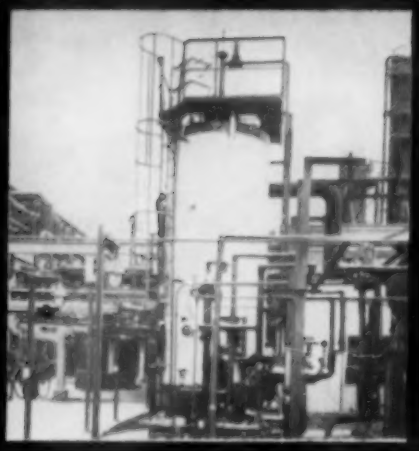
1955 REFINERY CATALOG

John Zink burners must be good

JOHN ZINK COMPANY

4401 South Peoria Ave. Tulsa 5, Oklahoma

A NEW CONCEPT IN LIGHT OIL REFINING



PETRECO ELECTROFINING

APPLICATIONS

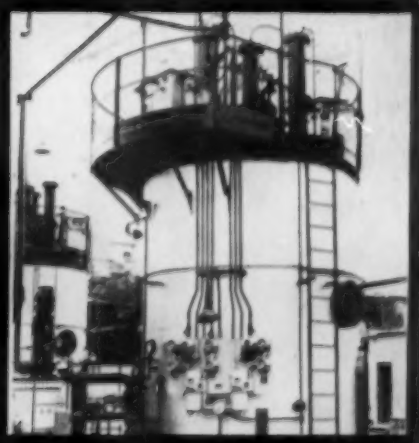
Caustic Scrubbing
Acid Contacting
Doctor Treating
Water Washing
Combinations of above

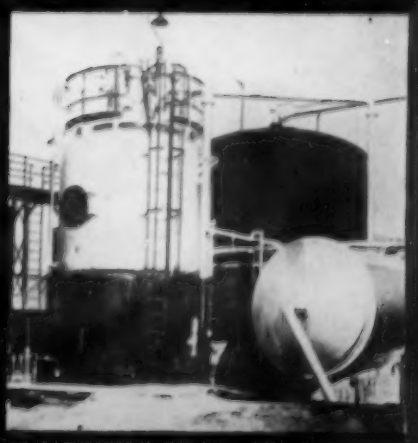
FOR TREATING

Catalytic gasoline
Diesel fuel
Burning oil
Kerosine
Jet fuel
Spray oil

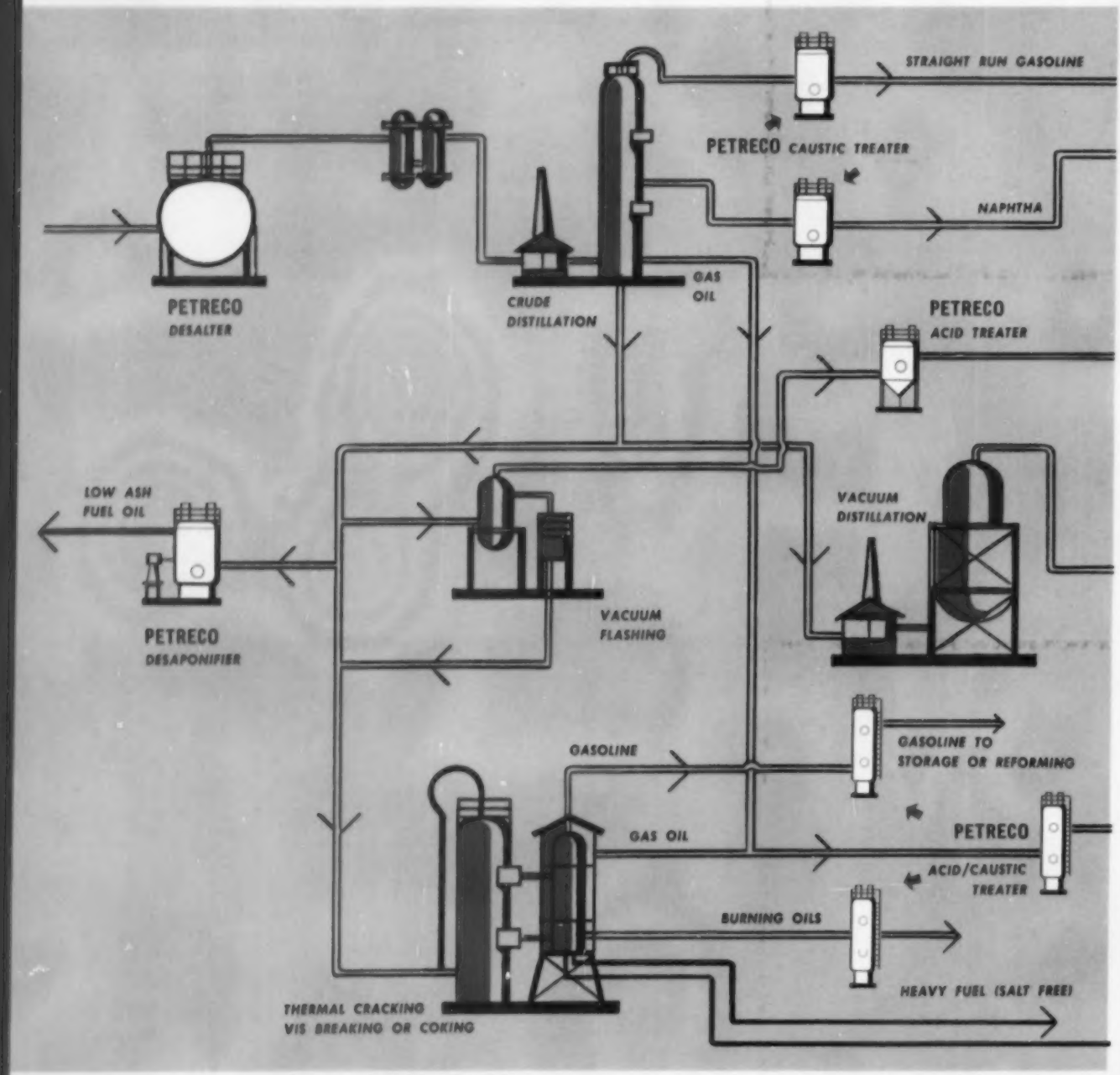
ADVANTAGES

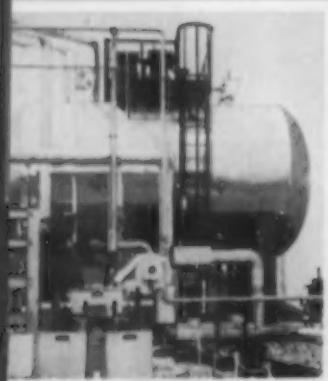
Compact
Clean
Automatic
Reliable
Continuous
Vapor tight
Fast treating
Economical





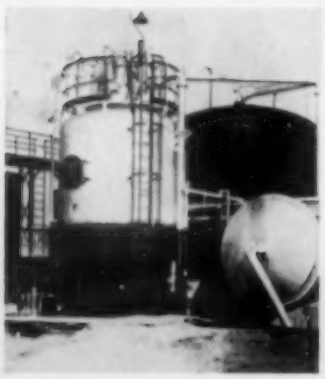
PETRECO electric processing.





Petreco Desalting

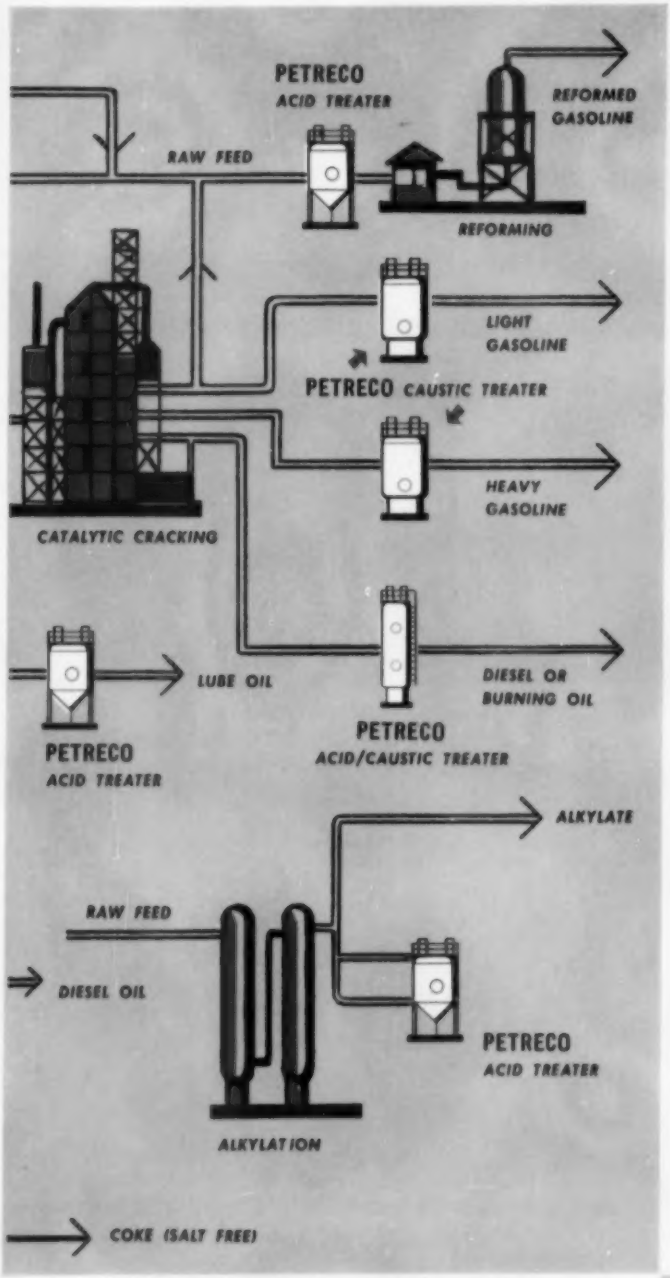
Petreco Desaponifier



Petreco Acid Treater

Petreco Doctor Treater

is widely applicable in refining



The treating of light petroleum stocks with acid, alkali or other chemicals is, of course, not a new concept in petroleum refining. However, the application of the forces of the electric field, as in Petreco *Electrofining*, is entirely new in this phase of refining. The *Electrofining* process provides a precision-controlled method for continuously contacting a light hydrocarbon stream with a treating agent, then separating the chemical phase from the treated product.

In the *Electrofining* process, automatic precision controls insure that the hydrocarbon stream is contacted with exactly the correct amount of treating chemical, in the proper intensity, and for a set, pre-determined time. All the variables are automatically controlled, guesswork is eliminated, and this type of refining becomes a science, rather than an art.

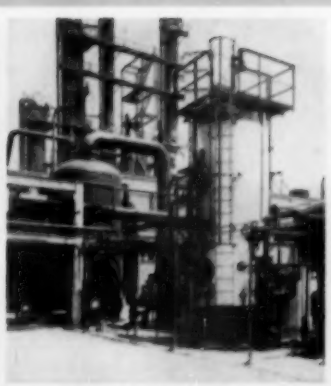
The automatic control features enable operating attention to be held at minimum. In contrast to conventional light oil processing where a number of operators often are required to treat one stream, one operator, using Petreco *Electrofiners*, can treat several streams.

In the *Electrofining* process, the powerful Petreco electric field causes a sharp, clean separation of the hydrocarbon and treating agent phases. Carry-over of treating chemicals in the finished product is minimized to such an extent that a water wash often is unnecessary. This low carry-over also saves a substantial percentage of treating chemical. In addition, the clean separation insured by *Electrofining* prevents the reaction products formed by caustic and tarry acids from causing a haze problem. One of the major advantages stemming from this feature is that settling time is cut from days to a few hours. This insures a more favorable use of storage facilities, since *Electrofining* eliminates the need for long settling periods to dehaze.

Electrofining delivers the product quickly, — from tower to market, with only the briefest treating period. Tarry acids, spent caustic, metals, mercaptans and other impurities are removed to the extent that the finished product passes all market specifications, such as Federal Alkalinity Tests, etc. The total metals in the *Electrofined* product average less than 1 PPM. *Electrofining*, in comparison with conventional processes requiring multiple treating vessels, usually is a one-unit, one-pass operation. However, the flexibility of the process is such that two-stage single units or dual units can be used, so that the exact treating sequence desired by the refiner is attained. Regardless of the combination desired, *Electrofining* will use less ground space, fewer pumps, less piping, fewer (and smaller) vessels and deliver a finished product ready for market in minimum treating and virtually no storage time.

OVER A DOZEN ELECTROFINING INSTALLATIONS ARE IN DAILY COMMERCIAL USE, AND MANY NEW ELECTROFINERS ARE BEING INSTALLED. WHY? BECAUSE ELECTROFINING NOT ONLY PROVIDES BETTER TREATING AND DELIVERS A MORE MARKETABLE PRODUCT — IT IS AVAILABLE AT A SUBSTANTIAL PRICE ADVANTAGE.

Petreco Caustic Treater



Petreco 2-Stage Treater

For further information, call or write

PETRECO

A DIVISION OF PETROLITE CORPORATION

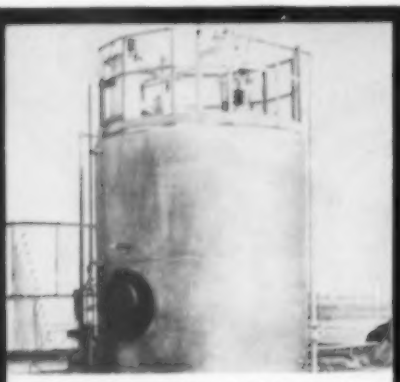
3202 South Wayside Drive, Houston 1, Texas

1390 East Burnett Street, Long Beach 6, California

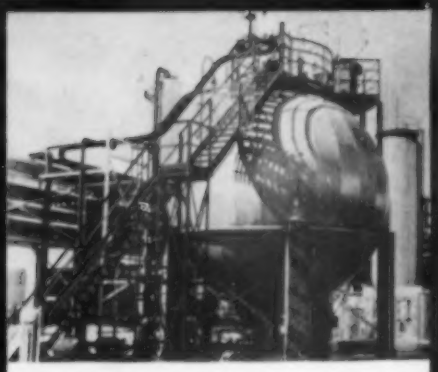
PETRECO *pioneered electric petroleum processing, and has originated all outstanding developments — ELECTROFINING is the latest.*

The Petreco organization installed the first electric petroleum processing plant, and ever since has carried on a continuing program of research that has resulted in outstanding advances in petroleum processing.

PETRECO AUTOMATIC ELECTRIC DEHYDRATORS
for breaking petroleum emulsions.



PETRECO SEDIMENT SEPARATORS
for removing sand, silt and fines from crude oil.



PETRECO ALL-ELECTRIC DESALTERS
for purifying refinery charging stock.

PETRECO DESAPONIFICATION EQUIPMENT
for purifying heavy fuel oil.

PETRECO ELECTROFINING PROCESSES
for treating distillates.

For complete information on any Petreco process, write or call

PETRECO®

A DIVISION OF PETROLITE CORPORATION

3202 South Wayside Drive, Houston 1, Texas • 1390 East Burnett Street, Long Beach 6, California

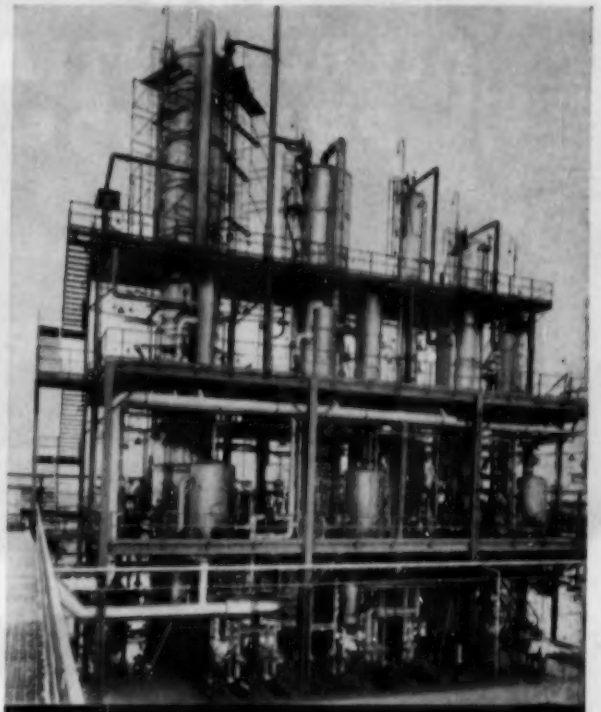
process know-how for LOWER ALIPHATIC

ALCOHOLS

CH_3OH
C_2H_5OH
iC_3H_7OH
nC_4H_9OH

FERMENTATION • SYNTHESIS
PURIFICATION
DEHYDRATION • RECOVERY

Vulcan's accumulated experience with lower aliphatic alcohols goes back over 50 years — covers hundreds of installations throughout this country and abroad — establishes Vulcan as the leading designer and constructor of plants and units for production and recovery of alcohols.



Large synthetic ethanol plant by Vulcan Engineering Division

- ★ Production of METHANOL by the Vulcan-Inventa Synthesis Process.
- ★ Production of ETHANOL by fermentation or by synthesis from ethylene.
- ★ Production of ISOPROPANOL by synthesis from propylene.
- ★ Production of N-BUTANOL by fermentation.
- ★ Dehydration by Vulcan's Pressure Process — applicable to the water-miscible alcohols which form constant-boiling mixtures with water.
- ★ Recovery and Purification of methanol, ethanol, normal propanol, isopropanol, normal butanol, secondary butanol, tertiary butanol, isobutanol and several of the amyl alcohols.

Vulcan's experience will provide the answers for many of YOUR problems in the production or recovery of the lower aliphatic alcohols. Your inquiry is invited.

VULCAN ENGINEERING DIVISION

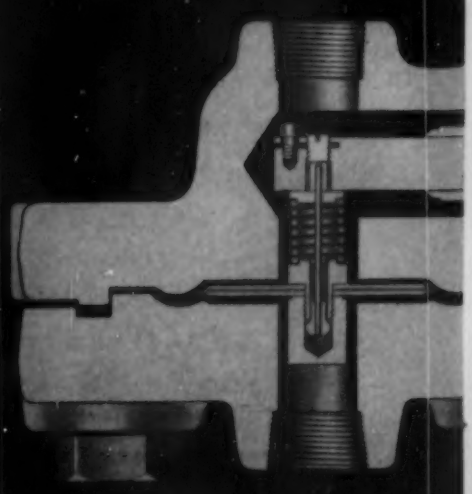
The VULCAN COPPER & SUPPLY CO., *General Offices and Plant,* CINCINNATI 2, OHIO

WILMINGTON, DEL. BOSTON HOUSTON SAN FRANCISCO
VICKERS VULCAN PROCESS ENGINEERING CO., LTD., MONTREAL, CANADA

DIVISIONS OF THE VULCAN COPPER & SUPPLY CO.:
VULCAN ENGINEERING DIVISION • VULCAN MANUFACTURING DIVISION • VULCAN CONSTRUCTION DIVISION

For more data on advertised products, use Readers' Service Cards, last page.

FOR
DIFFERENTIAL
PRESSURE
•
FLOW
•
LIQUID LEVEL



ONLY A MASONEILAN

Offers You All These

Meticulous attention to design details pays off in minimizing errors previously experienced with this type transmitter. Here's why:

▶ Has standard Masoneilan balanced, amplifying relay type pilot.

▶ Air passages all contained in sturdy mechanism frame — no tubing or fittings used inside cover.

▶ Damping unit is *sealed* — damping fluid cannot be lost in any position of the instrument.

▶ Heavy section mechanism frame bolted directly to diaphragm housing, and cover mounted to a floating plate, eliminating distortion due to outside forces acting on case.

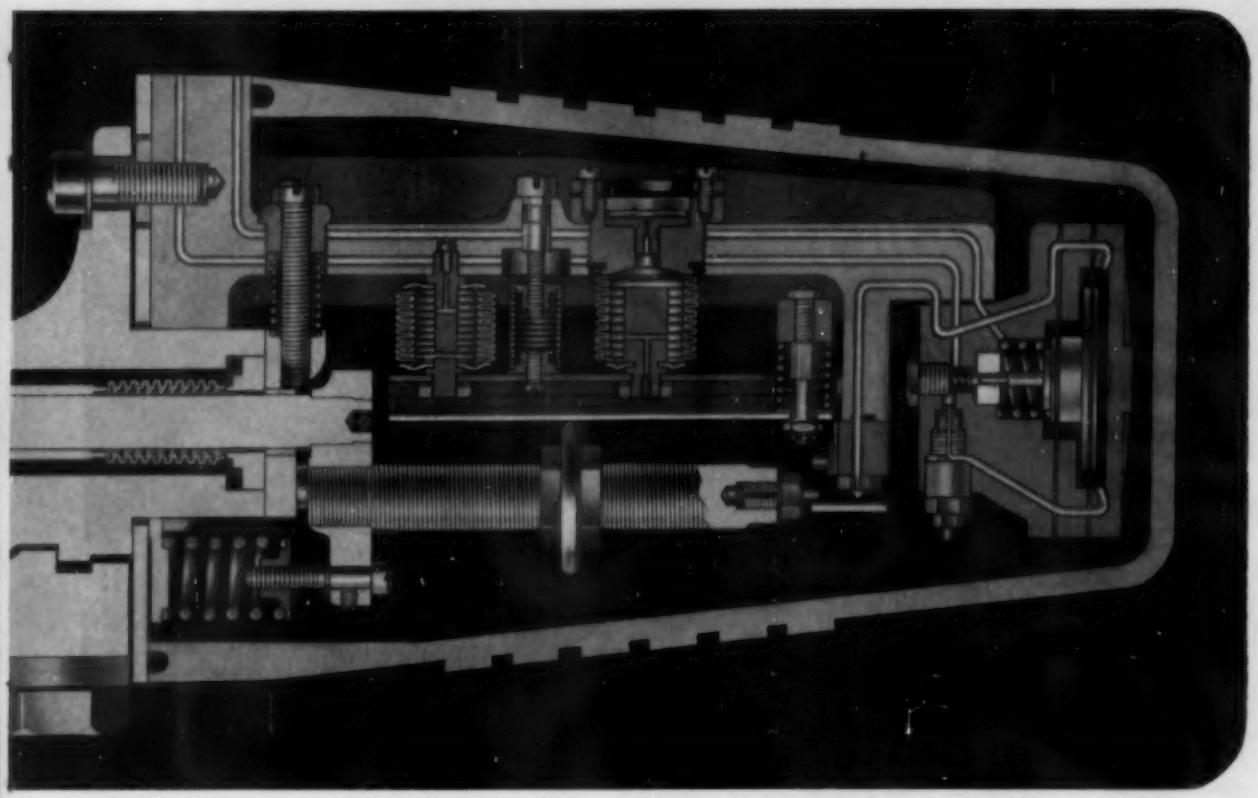
▶ Diaphragm housing is rugged AISI Type 316 stainless steel forging; avoids possibility of distortion from piping.

▶ Self-aligning, friction-free flexure bearings of beryllium copper for greater strength.

▶ Mounting is on diaphragm housing — point of greatest mass — insuring sturdy installation (see illustration at right).

▶ Adjustments provided with locks to insure retention of calibration.

▶ Overrange protection provided for differential pressure equal to maximum static rating. Diaphragm protected against overload or negative differential.



4800 DP TRANSMITTER

Advantages in One Instrument

▶ Extra heavy primary beam minimizes bending.

▶ Drain connections at lowest point in diaphragm housing; vent connections at highest point in diaphragm housing — insures proper venting and complete drainage of condensate on both high and low sides.

▶ Materials selected for maximum strength and accuracy with highest corrosion resistance and minimum temperature error (1% per 100°F ambient temperature change).

▶ These and other design features make Masoneilan Model 4800 Differential Pressure Transmitters outstanding among instruments of this type. Write for complete information.

SPECIFICATIONS

Range — Adjustable from 20" to 200" H_2O

Static Pressure Rating — 1500 psi

Ambient Temperature Rating — minus 30°F to plus 180°F

Weight — approximately 30 lb.

Pressure Connections — ½" NPT internal

Air Supply — 20 psi

Output — 3-15 psi

MASONEILAN

MASON-NEILAN REGULATOR CO.

1182 ADAMS STREET, BOSTON 24, MASS., U. S. A.

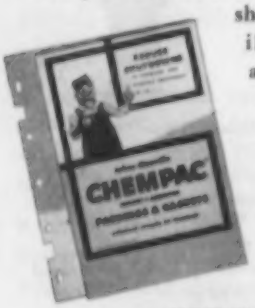
Sales Offices or Distributors in the Following Cities: New York • Syracuse • Chicago • St. Louis • Tulsa Philadelphia • Houston • Pittsburgh • Atlanta • Cleveland • Cincinnati • Detroit • San Francisco Boise • Louisville • Salt Lake City • El Paso • Albuquerque • Odessa • Charlotte • Los Angeles Corpus Christi • Denver • Appleton • Birmingham • New Orleans • Dallas • Seattle Mason-Neilan Regulator Co., Ltd., Montreal and Toronto

For more data on advertised products, use Readers' Service Cards, last page.

Now—J-M Chempac-Interlocked Packing combines both "Teflon" and asbestos protection

Johns-Manville now introduces Chempac®-Interlocked Packing, with three important advantages for service in chemical and process equipment. Interlocked provides the excellent sealing and heat resistant qualities of asbestos. It is braided by the unique and exclusive J-M method, so that the asbestos yarns are securely interlocked and cannot come apart in service. And it is treated with chemically inert Teflon*, which is almost universally resistant to chemical and solvent action.

Chempac-Interlocked can be used to pack pump rods or shafts, rotary filters, mixers and similar apparatus handling strong acids, alkalis, caustic solutions and many other reagents at temperatures to 500F.



Other J-M Chempac Packings and Gaskets for the Chemical and process industries

J-M Chempac Packings in coil, spiral and ring form. Made of asbestos, treated with Teflon, they are available in types for caustic, acid, chlorine and solvent service.

J-M Chempac Gaskets with Asbestos-Teflon base. They have high mechanical strength and heat resistance, with excellent sealability at low bolt stresses.

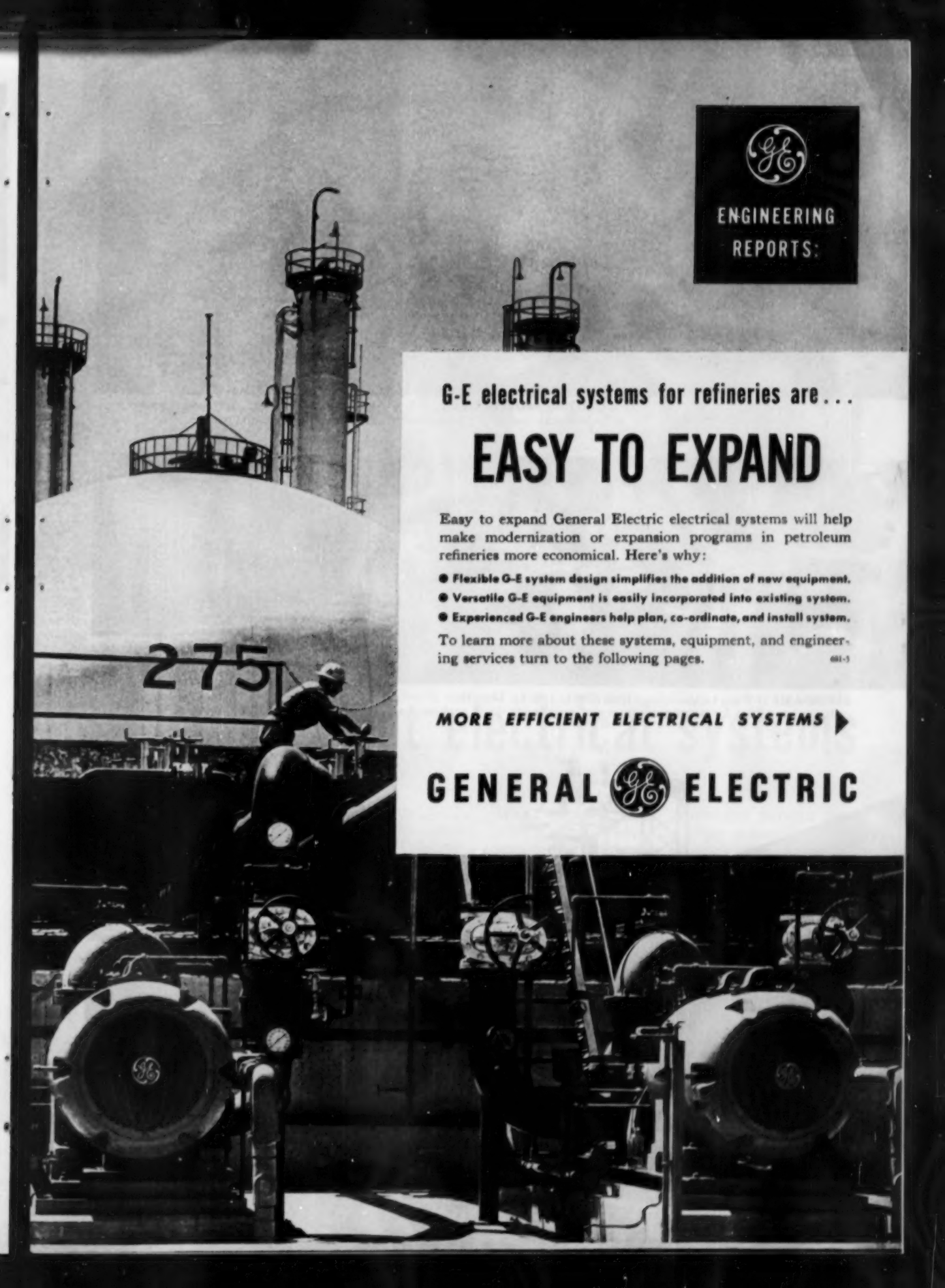
J-M Chempac Folded Gaskets designed for glass lined equipment. Asbestos-Teflon base gives them high sealing effectiveness against a wide range of chemicals.

J-M Chempac Spirotallic Flange Gaskets for perfect sealing in high temperature and pressure service, constructed of interlocked plies of metal and Teflon-Asbestos.

*Trade Mark of DuPont Tetrafluoroethylene resin

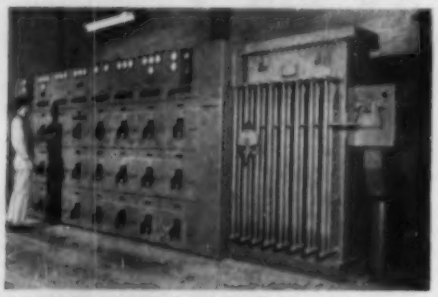
Free Folder gives complete details on Chempac-Interlocked and other J-M Chempac Packings and Gaskets for the chemical and process industries. For your copy of folder PK-80A write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

Johns-Manville PACKINGS & GASKETS


ENGINEERING
REPORTS:
G-E electrical systems for refineries are . . .
EASY TO EXPAND
Easy to expand General Electric electrical systems will help make modernization or expansion programs in petroleum refineries more economical. Here's why:
● Flexible G-E system design simplifies the addition of new equipment.
● Versatile G-E equipment is easily incorporated into existing system.
● Experienced G-E engineers help plan, co-ordinate, and install system.
To learn more about these systems, equipment, and engineering services turn to the following pages.
681-5
MORE EFFICIENT ELECTRICAL SYSTEMS
GENERAL ELECTRIC

UTILIZING PROCESS STEAM, G.E.'s complete range of steam turbine-generators provide electric power as a by-product, help maintain plant steam balance.

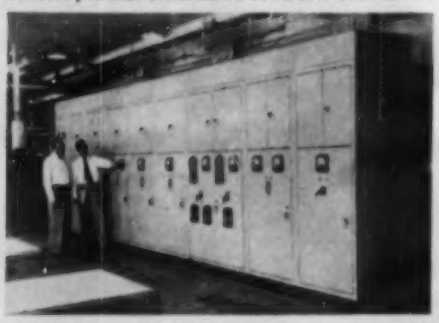
DEPENDABLE G-E gas turbines range from 6700 to 1700 hp. More than 55 units utilize exhaust heat for power generation and mechanical drive applications.



FACTORY ASSEMBLED G-E load center unit substations help cut installation time.

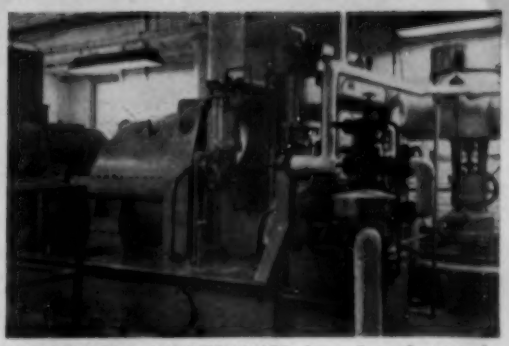
COMPLETE, COMPACT, G-E motor control centers provide centralized control in load areas.

MORE RELIABLE POWER DISTRIBUTION is available with G-E package substations which use co-ordinator transformers, metal-clad switchgear.

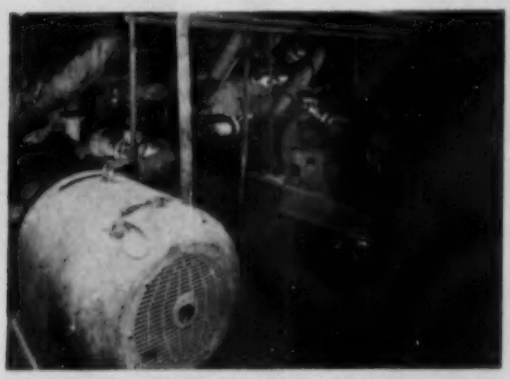


SAVE FLOOR SPACE with compact G-E Limit-amp control units.

DEPENDABLE G-E d-c motor generator sets are designed to operate in continuous service at top efficiency. Minimum of maintenance is a key feature of these sturdy generators built for long life.



ECONOMICAL MAINTENANCE is a key feature in design of G-E mechanical drive turbines.



RUGGED CONSTRUCTION of G-E Tri-Clad* motors make them ideal for all types of drive operations. Polyex insulation in motors 100-3000 hp gives 50% longer motor life.

*Reg. Trademark of General Electric Co.

G-E engineering services, equipment can give you . . .

More efficient electrical systems

MODERNIZING, EXPANDING, BUILDING? Whatever your plans, let experienced G-E engineers help plan a more efficient electrical system for you. They will work with you or your engineering contractors to give you correct answers to the following questions.

SHOULD YOU GENERATE OR PURCHASE POWER? G-E engineers will help make a "load" survey of your facilities, and recommend an economical solution to your particular power supply problem.

WHAT TYPE ELECTRICAL DISTRIBUTION SYSTEM SHOULD YOU INSTALL? The latest distribution system concepts will be reviewed with you by G-E engineers. They will help select and design a modern system to meet your individual requirements.

WHAT KIND OF DRIVE EQUIPMENT SHOULD YOU USE? Each application for drives in your processing lines will be individually examined by G-E engineers to assure that the proper drive is designated for the job.

WHERE CAN YOU UTILIZE AUTOMATIC CONTROLS? New developments in the field of automatic controls will be applied throughout your processing lines by G-E engineers.

Let your General Electric Apparatus Sales Representative get you detailed answers to these and other electrical questions. Contact him at your nearest G-E Apparatus Sales Office early in your planning stages. General Electric Company, Schenectady 5, N. Y. 681-5

PROTECT YOUR EQUIPMENT INVESTMENT ▶

Engineered Electrical Systems for Process Industries

GENERAL ELECTRIC

SIX G-E ENGINEERING SERVICES . . .

HELP YOU PROTECT YOUR EQUIPMENT INVESTMENT

1 **G-E APPLICATION ENGINEERING** helps you and your consultants design the right electric system for your plant.

2 **G-E ANALYTICAL ENGINEERING** helps attain the optimum electrical system for your application. Engineering experience backed up by electronic system analyzers save valuable design time.

3 **G-E PRODUCT DEVELOPMENT** laboratories design and test new equipment under tomorrow's conditions to meet your future demands.

4 **G-E FIELD-SERVICE ENGINEERING** helps you supervise installation, expedite start-up of your major electric equipment.

5 **G-E MAINTENANCE SERVICE** from 31 G-E Service Shops will repair and uprate your old equipment, help establish productive maintenance of your equipment, furnish emergency service.

6 **G-E PROJECT CO-ORDINATION** means on-time engineering, shipment, installation of your electric equipment from preliminary diagrams through start-up.

These valuable services are available to you with General Electric equipment. Contact any General Electric Apparatus Sales Office. Meanwhile, for the full story of G-E engineering services, write for brochure GED-2244, General Electric Co., Sect. 681-3, Schenectady 5, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

WEED PROBLEMS?

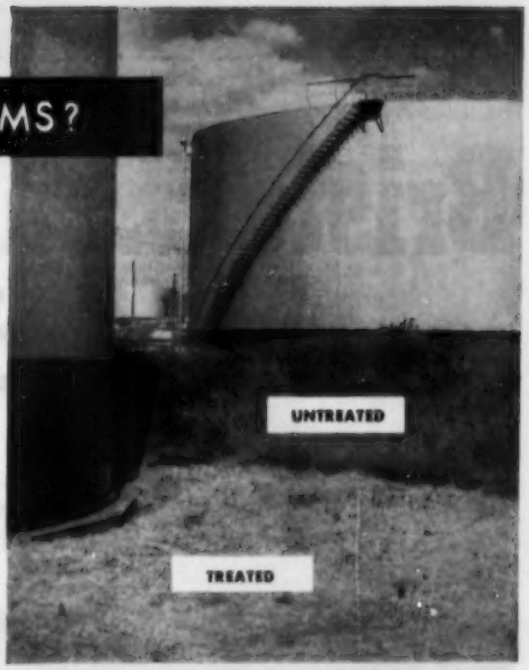
One application of

Du Pont Telvar®

WEED KILLERS

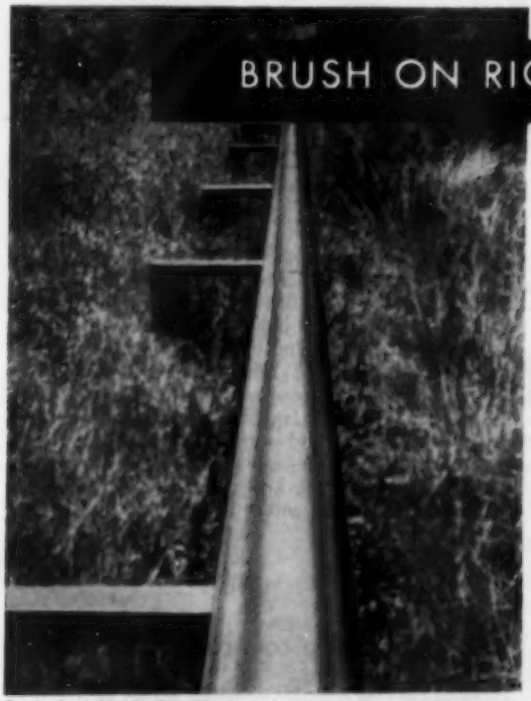
stops weeds for the season—or longer!

"Telvar" kills weeds through the roots . . . prevents regrowth. Low rates (20 to 80 lbs. per acre) make it cost little for the results you obtain . . . also mean less handling, fewer storage problems. To cut maintenance costs to new low levels, put "Telvar" in your weed-control program. Available in two formulations: "Telvar" W, and "Telvar" DW.



"Telvar" is ideal for weed control around tank farms, pipelines, pumps and derricks. It's non-toxic to humans and animals, non-flammable, non-volatile and non-corrosive to equipment.

BRUSH ON RIGHT-OF-WAY?



Brush along this pipeline was cleared and kept down with "Ammate." "Ammate" allows low-growing cover to return to resist erosion.

One application of

Du Pont Ammate®

WEED AND BRUSH KILLER

kills more kinds of brush —safely—at lower cost!

"Ammate" kills more kinds of brush and keeps it down longer than most weed and brush killers! When the original spray job is done well, brush is kept under control for years with only an occasional spot spray. You can rely on "Ammate" to do the job safely, even where your right-of-way adjoins cropland, because "Ammate" is not volatile. There are no vapors to drift onto sensitive crops. It is no hazard to crews, stock or wildlife.

FREE ILLUSTRATED BOOKLETS describe how to control weeds and brush with Du Pont chemicals. For your copies, write to Du Pont, Grasselli Chemicals Dept., Rm. D-4032, Wilmington, Del. In Canada, Du Pont Company of Canada Limited, Box 660, Montreal.

On all chemicals always follow directions for application. Where warning or caution statements on use of product are given, read them carefully.

Telvar® Weed Killers for industrial use

DU PONT
REG. U. S. PAT. OFF.

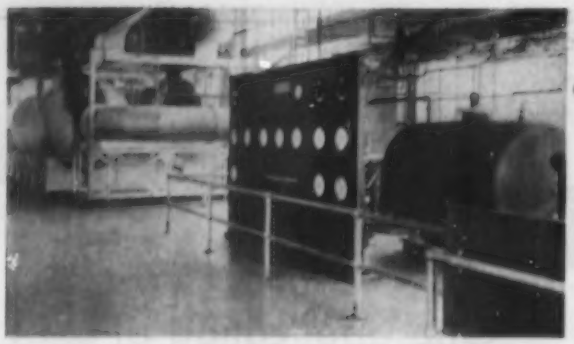
Ammate® Weed and Brush Killer

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTR

WHAT'S NEWS AT BRISTOL . . . WHAT'S NEWS AT BRISTOL

Bristol... automation... and you

Magic word, automation. Or push-button operation. It's a breath-taking concept, too – plants running practically unattended.
Breath-taking – but not *new*.



BRISTOL COORDINATED CONTROL SYSTEM automatically controls operation of "Columbia" Activated Carbon Solvent Recovery Plant at the New York Daily News. Similar control systems are used in many other solvent recovery plants designed and supplied by Carbide and Carbon Chemicals Company, a Division of Union Carbide and Carbon Corporation.

BRISTOL'S "MECHANICAL BRAIN" is the leader of the Coordinated Process Control System . . . accurately coordinating all the variables, including mechanical operations, so that each phase of the process takes place in proper sequence.

AUTOMATION is often thought of in terms of plans or even dreams; here at the Buffalo Foam Rubber Products Plant of the Dunlop Tire and Rubber Corporation, it is a reality. This automatic plant, designed and built by Mechanical Handling Systems, Inc., Detroit, uses Bristol Dynamaster® Electronic Instruments and Automatic Controllers as part of a process employing today's most advanced automatic production techniques. The result – greater efficiency and productivity, lower costs, improved product, and stronger competitive position.

THE WORLD'S LARGEST COAL CLEANING PLANT employs automation in lubricating system. The Hanna Coal Co., Adena, Ohio, uses *Bristol Controls and Recorders* in its fully automatic time-controlled centralized system for mass lubrication. This system promotes safety and, above all, insures positive delivery of the right lubricant in the right quantities at the right time to all bearings, regardless of operating conditions.

For more data on advertised products, use Readers' Service Cards, last page.

Twenty-one years ago . . .

'Way back in 1934, The Bristol Company led the way in the field of automation by developing the Bristol Systems of Coordinated Process Control.

These systems automatically controlled and coordinated all of the variables and operations of a process—such as the time of operation of valves, pumps, blowers, dampers, and the control, at a definite value or according to a time program, of variables that affected the uniformity, quality, cost, and yield of a product – such as temperature, pressure, liquid level, flow, pH, humidity, and speed.

RESULTS: They eliminated variations in processing that caused inefficiency – cut down rejections and waste – insured product uniformity – helped cut processing time as much as from 10 days to less than 30 minutes. And these systems quickly paid for themselves.

A REVOLUTIONARY CONCEPT: They brought automatic plant operation to a startling reality and were hailed at the time as a fundamentally new development – which would in time revolutionize manufacturing.

Today, Bristol Coordinated Control Systems are used in the chemical, oil refining, rubber, tobacco, textile, steel, metal working, food, paper, the automotive industries, and many others. They are so completely automatic that it is only necessary to push a button to start up, another to shut down.

The modern solution to processing and manufacturing control problems

Bristol's System of Coordinated Process Control is made possible only by the following unique combination of facilities, which have been developed during 66 years of building and applying thousands of automatic control systems and instruments in practically all industries:

1. The complete line of modern Bristol Automatic, Controlling, Recording, Electronic, and Telemetering Instruments, representing some of the most advanced ideas in instrument engineering.
2. Bristol's Fully-Automatic Time-Cycle Controllers or "Mechanical Brains".
3. Bristol's ability to combine electronics and the mechanical phases of automation.
4. The ability and facilities of Bristol's engineering staff, gained by long experience and Bristol's pioneering work in the field of automation.

Bristol Application Engineering is at your service:

Our application and field engineers are ready to solve control problems involving automation and Coordinated Process Control Systems by working jointly with your research, development, and plant engineers.

Have you an automation problem?

Our application engineers and nation-wide group of field engineers would like an opportunity to work with your technical staff on any problems of automation for which Bristol Controlling and Recording Equipment and Bristol Coordinated Control Systems appear to be the solution.

8.3

BRISTOL PRODUCTS:

Automatic Controlling, Recording, and Telemetering Instruments for:

Pressure, Vacuum, Absolute Pressure, Draft, Differential Pressure, and Barometric Pressure.
Temperature (Thermometers, Potentiometers and Pyrometers).
Flow, Water and Liquid Level, and Specific Gravity.
pH and Conductivity.
Speed of Travel and Rotation.
Humidity.
Voltage, Current, Power, and Load Totalization.
Mechanical Motion, Position and Operations

Including:

Automatic Control Systems
Electronic Potentiometers
Graphic Panel Instruments
Time-Cycle Controllers
Time-Program Controllers
Pneumatic and Electric Controllers
Instrument Panels
Control Valves

Write to The Bristol Company, 111 Bristol Road, Waterbury 20, Conn.

BRISTOL

BRISTOL'S

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

Net game or Net gain...

there's enough difference to make ALL the difference

In tournament tennis, a player's net game is one of the differences that make a champion. Likewise, significant differences in quality and performance engineered into Scovill Heat Exchanger Tube add up to a *net gain* for you in better operating results and less frequent maintenance shutdown of key units.

Scovill Phosphorized Admiralty Heat Exchanger Tube is "born" differently. It is initially hot-extruded from billets *continuous-cast* by Scovill's pioneer process. The result is sound metal through and through — smooth, dense, free from pits or porosity — and a new uniformity of chemical composition, with optimum, evenly distributed phosphorus content.

These differences alone can make *all* the difference in your operating record. But when you add them to Scovill's unequaled Technical Application Services, you have a combination you can't afford to pass up. Ask us to prove it.

Scovill Manufacturing Company, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone PLaza 4-1171.

SCOVILL **HEAT EXCHANGER TUBE**

Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Muntz Metal • Naval Brass • Red Brass, 85% • Deoxidized Copper • Arsenical Copper • Copper Nickel, 10% & 20% • Cupro Nickel, 30% • Aluminum Brass • Aluminum Bronze, 5% • Duplex Tube

149C88

Safety at the L.P.G. loading rack — thanks to Rockwood Ball Valves

This Eastern loading rack runs no risk of gas seepage when trailer tankers are being filled. Rockwood Ball Valves are the reason why.

The quick opening and closing of these valves is a tremendous asset during loading. But of primary importance is the fact that Rockwood Ball Valves are *leakproof*.

These four exclusive features guarantee the trouble-free performance and efficiency of Rockwood Ball Valves —

Full Round Flow — no change in shape or volume of fluid stream — no turbulence — no minimum loss.

Quick Opening and Closing — only a quarter turn needed.

Longer Wear-Resistance — chrome-plated bronze ball withstands abrasion, pitting and scratching.

Leakproof Seal — pressure of fluid automatically positions ball against seat to form tight seal.

If you are not now using Rockwood Ball Valves, send coupon today for complete information. Valves come in all pipe sizes. Tested and listed by Underwriters' Laboratories, Inc.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
565 Harlow Street
Worcester 5, Mass.

Send me illustrated folder V-4 on Rockwood Full-Flow Ball Valves.

Name_____

Title_____

Company_____

City_____

Zone_____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

Corrosioneering News

Quick facts about the services and equipment Pfaudler offers to help you reduce corrosion and processing cost.

Published by The Pfaudler Co., Rochester, N.Y.

CORROSION GUARANTEE ANNOUNCED!

Now—a year's corrosion guarantee on Pfaudler vessels used in processes containing hydrochloric acid!

If your product has hydrochloric acid as its principal corrosive agent, and you operate in the range represented by the darkest area on our chart, you can now have processing equipment which carries a full year's guarantee against corrosion!

If chemical attack should render your Pfaudler glassed steel equipment unusable within its first year of use under the operating conditions specified in the guarantee, Pfaudler will replace or repair it without charge by on-the-spot methods or on an F.O.B. factory basis.

You receive this guarantee on all glassed steel equipment supplied with Pfaudler acid-alkali-resistant glass, when it is expressly purchased for processing hydrochloric acid in the specified range of conditions. Such equipment includes reaction kettles, stills, receivers, condensers, heat exchangers and storage tanks.

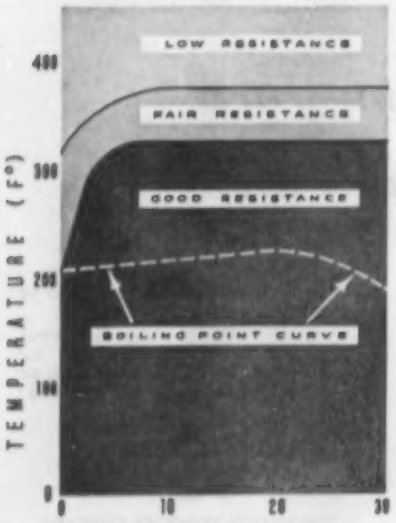
The guarantee, in written form, is delivered with the equipment, and states clearly the operating conditions under which it applies.

You'll find three important advantages in this unique guarantee:

1. It minimizes the possibility of major shutdowns caused by corrosion of equipment.
2. It frees you from large maintenance or replacement costs.
3. It assures you that the glassed steel equipment you buy is *matched to your process*, selected for its special resistance with reference to *your* product.

Perhaps you have a problem right now, for which this guaranteed corrosion-resistant equipment offers a solution. Call in your Pfaudler representative and discuss your needs with him.

Or write for Bulletin 205, "Glassed Steel—Its Resistance to 92 Corrosives, Forms Available and Applications."



Corrosion resistance of Pfaudler acid-alkali-resistant glass by hydrochloric acid. For concentrations and temperatures in darkest area, glassed steel equipment is guaranteed against corrosion. In the "fair resistance" and "low resistance" areas, Pfaudler glassed steel may often be the most resistant material of construction available to you at reasonable cost. To make this decision, Pfaudler should be consulted, and tests may be run in either your plant or at the Pfaudler laboratory.

Glassed Steel Long Used For Tough Corrosive Problems

Field data which orm the basis for Pfaudler's new guarantee against corrosion has been compiled from thousands of installations, such as these glassed steel reactors in use at Distillation Products Industries. Pfaudler glassed steel units have solved problems of corrosion since 1884, are continually being improved to meet new demands of higher temperatures and pressures.

Three reasons why you can now get this unusual anti-corrosion guarantee

Like all Pfaudler chemical processing equipment, glassed steel *always* has been guaranteed from the standpoint of workmanship.

But why is it that you can now get a *corrosion* guarantee—a written agreement that your equipment will hold up under corrosive attack for at least a year?

Reason No. 1 is the glass itself. Pfaudler's new acid-alkali-resistant glass, now standard on chemical processing equipment, is a special type of glass which not only resists most acids, but also can be used for alkalies up to pH 12 and 212° F.

Reason No. 2 is the sensible approach to a specific problem by corrosioneers. We know what glassed steel can do, *and* what it can't. Field and laboratory data provide the background for deciding between glassed steel and other materials.

Reason No. 3 is our general policy on the equipment we sell. During its fabrication, we inspect it carefully at several check points. No vessel for severe chemical service leaves the factory until every square inch inside has been given a spark test to make sure the glass completely covers the steel to a certain minimum thickness.

12-MONTH GUARANTEE against corrosion is now offered with Pfaudler glassed steel equipment for processing a number of specific chemicals; hydrochloric acid, discussed in this article, is one of them. Other products which are covered under this unique guarantee will be discussed in future issues of *Corrosioneering News*. Watch for them.

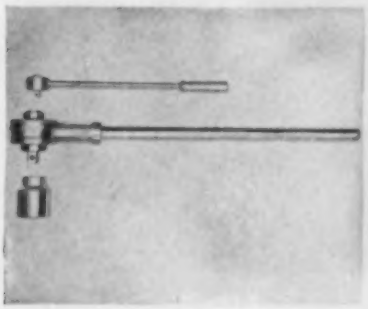
For more data on advertised products, use Readers' Service Cards, last page.

NEW EQUIPMENT:

New "4-to-1" Geared-Head Unit

generates high torque in limited space with less effort

Bonney Forge & Tool Works, Allentown, Pa , has just announced a new "4-to-1" geared-head wrench for heavy assembly and disassembly work requiring rotary effort over 200 ft. lbs. *An intermediate unit*, the "X-4" is designed for use with ratchets, torque wrenches, sockets, and attachments. Torque is produced through planetary gears.



½" square drive ratchet with Bonney 750X-4 geared-head unit and ¾" square drive socket.

A small, rugged, compact unit, the Bonney X-4 is lightweight and portable . . . ideal for work in close quarters. It makes tightening of threaded parts to specific torque easy and accurate. Known 4-to-1 ratio permits its use as a multiplier for torque wrenches.

In tightening or loosening threaded parts, there is no dangerous snap or jarring action. Easily used in shop or field applications, the Bonney X-4 eliminates need for extra manpower. A mechanic can do his own job with less exertion, greater safety, and without damaging the equipment.

The new X-4 has a drop-forged, heat-treated chrome-moly steel head. All highly stressed parts (including detachable anchor bar) are made of specially heat-treated alloy steels—selected for maximum efficiency and strength. Head and shafts are sealed and lubricated for life.

Complete information is available from: *Bonney Forge & Tool Works, Allentown, Pa.*

1 man + Bonney X-4 = 4 men

New!

Revolutionary!

Labor-Saving!

It's the new BONNEY "X-4"—the amazing, muscle-saving 4-to-1 Geared-Head Wrench! Now, 1 man can do the job of 4 in all heavy assembly and disassembly work! In tightening or loosening threaded parts, there is no dangerous snap or jarring action. The Bonney X-4 *makes tough jobs easy!*

The new BONNEY "X-4" is designed as an *intermediate unit* for use with ratchets, torque wrenches, sockets, and attachments. Rugged, lightweight, portable—the unit is easily used in shop or field. A mechanic can do his own work with less effort, greater safety, with no chance of damaging equipment.

Get the complete story!

BONNEY TOOLS

BONNEY FORGE & TOOL WORKS
Allentown 3, Pennsylvania

Please send me detailed information on the new BONNEY "X-4" 4-to-1 Geared-Head Wrench.

Name_____

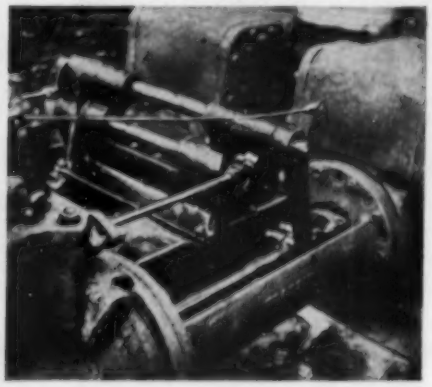
Company_____

Address_____

City_____ Zone_____ State_____

In this tank, where oils are treated with sulfuric acid, a coned bottom made of ½-inch Monel plate has successfully withstood corrosion since its installation in 1950.

Monel rods in acid sludge pumps at Atlantic's Philadelphia refinery last 10 to 12 months as compared to 5 months for brass or carbon steel. Service is severe since sludges must be steamed to increase their mobility.



Recent practice in

Controlling Dilute Sulfuric Acid and Acid Sludge Corrosion

When it comes to handling sulfuric acid and acid sludges in the refinery, there is a realm where neither lead, steel, nor copper-base alloys answer the equipment problem adequately. In such cases, the high-nickel alloys have often proved to have the most useful combination of chemical and mechanical properties.

For example, The Atlantic Refining Company had to repair a large outdoor tank used for acid treatment of light industrial oils. They wanted a better material for the coned bottom, in which deposits of acid sludge accumulate, and decided to try Monel. That was in 1950. The Monel was installed and has stood up without any need for repair ever since.

Similarly, when Atlantic found they were getting only 5 months' service from brass or steel rods in their acid sludge pumps, they substituted Monel. The Monel rods have been giving 10 to 12 months service. (Even longer service has been reported with heat-treated "K" Monel rods which also have greater resistance to scoring.)

Monel is also used in many refineries for valves and lines handling dilute sulfuric acid.

In general, Monel is used to handle sulfuric acid where a combination of good corrosion resistance and high mechanical properties—high strength and little or no creep—are needed. Its practical application is limited to reducing conditions and to concentrations below 80-85% at room temperature (or 12-15% in boiling solutions).

More information on controlling sulfuric acid corrosion is contained in Inco's Technical Bulletin T-3, "Resistance of Monel, Nickel and High-Nickel Alloys to Corrosion by Sulfuric Acid." It is yours on request.

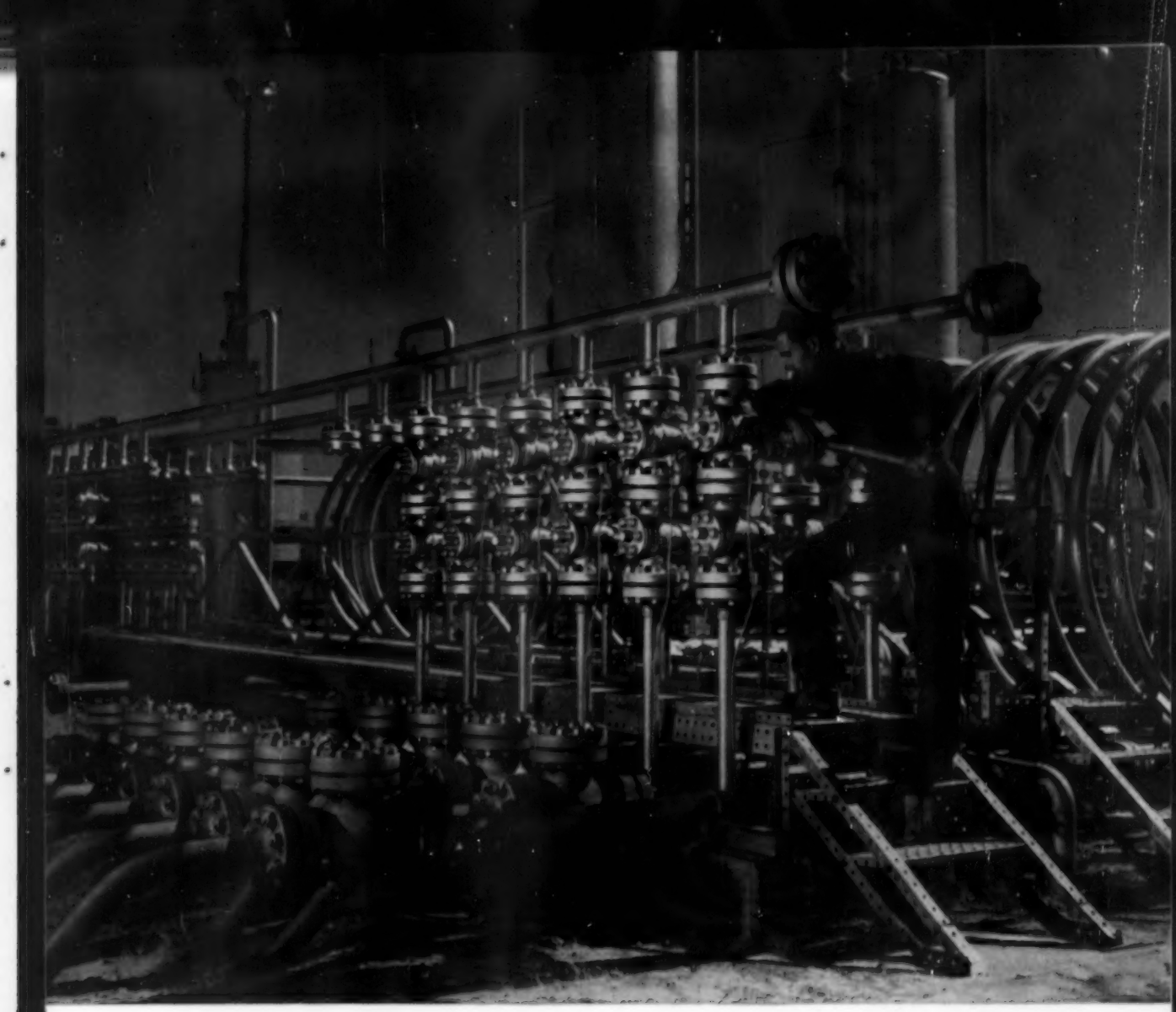
And if you have such a corrosion problem, be sure to contact Inco's Corrosion Engineering Section. They will be glad to help you without cost or obligation.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO Nickel Alloys

Monel ... *for minimum maintenance*

For more data on advertised products, use Readers' Service Cards, last page.



Profit-Making

Lubricating a Rockwell-Nordstrom valve periodically is not just another maintenance item; it's a profit-making investment in low-cost operation. The advantages are the same as those you get from lubricating your automobile engine: increased efficiency and longer life at lower end-cost.

Rockwell-Nordstrom lubrication saves you money in three important ways: 1. eliminates wear of metal-to-metal friction; 2. provides a constantly renewed seat for leak proof sealing; 3. allows the plug to be hydraulically jacked for instant operation when necessary.

Today's Rockwell-Nordstrom quality is the result of forty years of leadership in building the most complete line of lubricated plug valves and plug valve lubricants in the world. Why not use that unequaled experience to cut *your* valving costs! Rockwell Manufacturing Company, Pittsburgh 8, Pa.

ROCKWELL-Nordstrom VALVES

LUBRICANT SEALED FOR POSITIVE SHUT-OFF

Put New Profits in Production

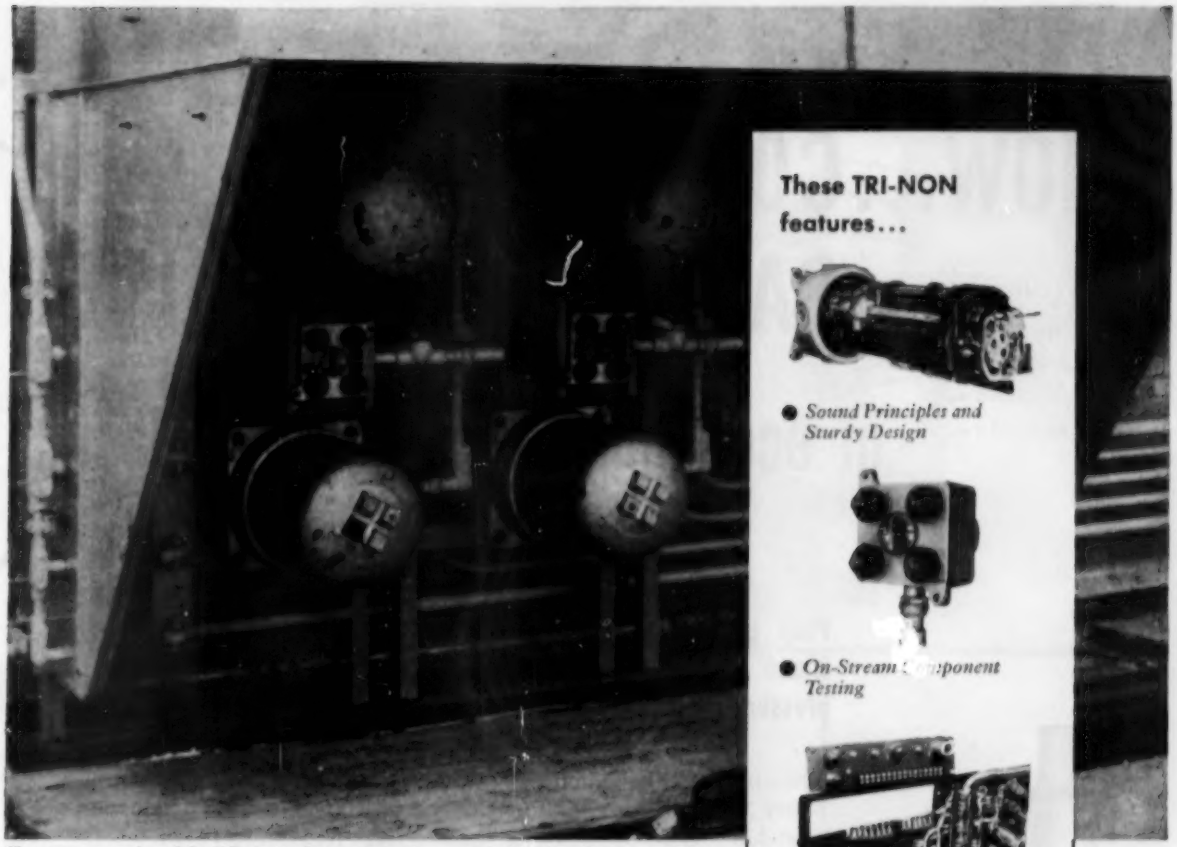
Is controlling the flow of liquids, solids, gases or slurries part of your production problem? Rockwell-Nordstrom valves will do a *better* job —at lower cost—than any other valve you've ever tried.

Pressure lubrication that forms the leak proof seal in Rockwell-Nordstrom valves has the same importance whether your flow problem is cement slurries or light hydrocarbon gases. Quarter turn operation gives you precision control whether you're batching chemicals or measuring fuel. And tough lubricant film protection of metal working surfaces, plus unexposed seating areas, means longer valve life whether your lines carry pulp liquors or synthetic rubber.

You can't buy a more dependable, more efficient valve than Rockwell-Nordstrom—or one that will cost you less to use. Write for complete information today. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

ROCKWELL-Nordstrom VALVES

LUBRICANT SEALED FOR POSITIVE SHUT-OFF

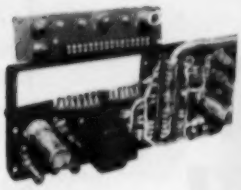


TRI-NONs *monitor CO, CO_2 in feed streams at Cyanamid's Fortier Ammonia unit.*

These TRI-NON features...

● *Sound Principles and Sturdy Design*

● *On-Stream Component Testing*



● *Rapid Interchange of Components*

...add up to dependability plus quick and easy maintenance

TRI-NON* Analyzers lengthen time between turnarounds... reduce operating costs

In addition to providing important analytical control on process streams, continuous infrared analyzers can be a highly important factor in preventive maintenance. Where product mix conditions in a process stream may lead to fouling, catalyst poisoning, afterburning, etc., analyzers will give immediate warning of such conditions in time to take corrective steps.

FOR EXAMPLE, the two TRI-NON Analyzers at American Cyanamid Company's new Fortier plant protect the catalyst in the ammonia reactor from poisoning by oxygen compounds, thus reducing risk of costly shut-downs. In another unit, TRI-NON Analyzers are used to monitor the feed composition going to the acetylene burners so as to maintain smooth operation and desired acetylene concentrations in the burner exit gas.

Many refineries have installed analyzers in the off-gas of "cat" crackers to follow CO concentrations, since an increase in this gas is an accurate, early indication of the development of an afterburning condition.

Perkin-Elmer TRI-NON Analyzers are available in a wide range of models and prices to meet all types of continuous analytical problems. They are rugged and dependable, expressly designed for use in the varied environments of the processing plant or refinery. And they are backed by Perkin-Elmer's experienced engineers who are ready to provide expert guidance in their application and installation.

THE PERKIN-ELMER CORPORATION *FIRST IN ANALYTICAL CONTROL*

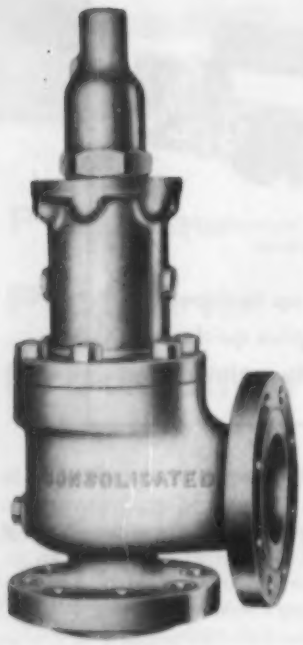
NORWALK, CONNECTICUT • Offices in New Orleans • Chicago
Silver Spring, Maryland • Zurich, Switzerland

*The Perkin-Elmer Corporation

NOW... CONSOLIDATED SAFETY RELIEF VALVES

in economical "2 in 1" design

Peak performance . . . positive valve action assured . . . even where discharge lines are long, or low "superimposed" back pressure exists in the relieving system.



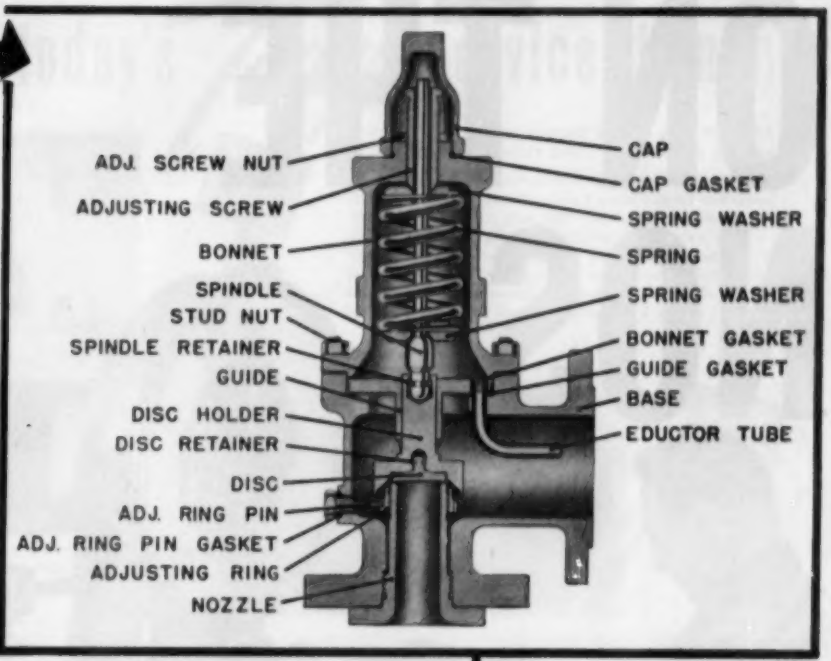
"Two-In-One" design, improved performance . . . the new Consolidated Safety Relief Valve is the result of over 4,000 flow tests in 5 years at West Edmond, Oklahoma. At the A.S.M.E.-approved testing station there, natural gas is available in flow capacities up to 35,000 cfm and pressures up to 500 psig. The A.S.M.E.-approved conditions, apparatus, and procedures permitted Consolidated engineers to test-develop and prove the full range of valve sizes and pressures in both Standard and Bellows designs.

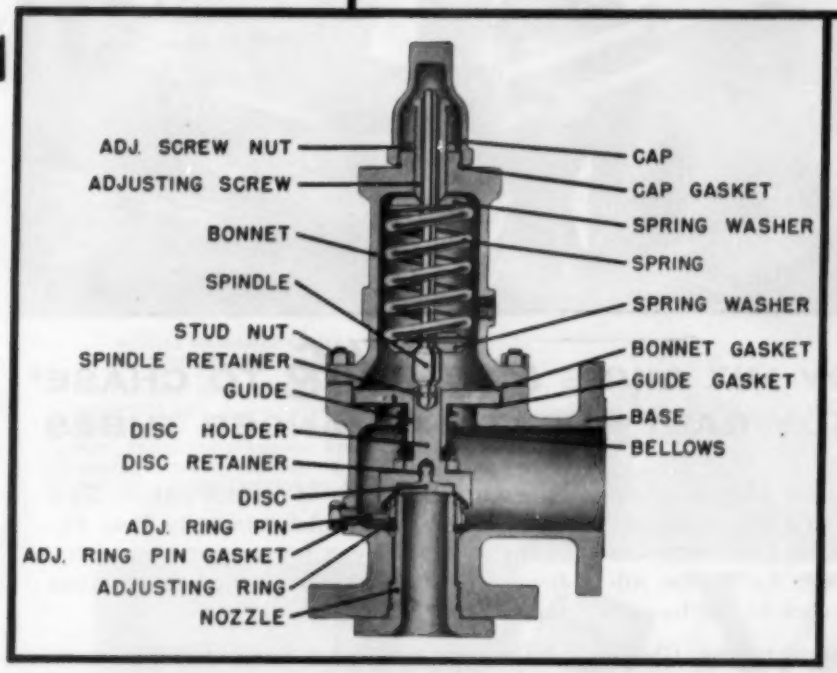
Interchangeability is so highly developed that the majority of Consolidated Standard Valves can be converted to the Bellows design, in the field, simply by installing the bellows. Each type has fewer functional parts than other comparable safety relief valves. Standardization of inlet and outlet center-to-face dimensions permits interchangeability with a large proportion of the valves of other manufacturers. Incorporated is an optically-ground flat seating surface that contributes to easier, more economical maintenance.

You can have the absolute protection and real economy of the thoroughly tried and proved Consolidated Safety Relief Valves for your plant today. Both Standard and Bellows types are available in sizes and pressures to meet requirements of the most advanced processing facilities. Write for full details. Ask for Catalog 1900.

CONSOLIDATED SAFETY RELIEF VALVES

STANDARD VALVE has an eductor tube that holds the pressure in the valve bonnet to approximately atmospheric pressure; thus only the force of the spring controls the valve. Valve action is improved and stabilized . . . repetitive flow capacity is provided . . . a new high in operational dependability is assured. Even under repeated popping of the valve, set pressure and blowdown are consistent. The valve will open to full capacity at 3% overpressure regardless of the position of the adjusting ring.





BELLOWS VALVE is like the Standard but has a durable, two-ply stainless steel sealing bellows which effectively isolates from the valve's working parts any contaminants, corrosion, or viscous fluids. The bellows is balanced with the seating surface: set pressure of the valve is not affected by back pressure, whether constant or variable. Consequently, smaller discharge piping can be used, thus reducing the cost of pressure-relieving systems.

Certified and Approved

Both Standard and Bellows Valves are approved under A.P.I.-A.S.M.E. Unfired Pressure Vessel Codes, A.S.M.E. Unfired Pressure Vessel Code and are certified by the National Board of Boiler and Pressure Vessel Inspectors.

A PRODUCT OF MANNING, MAXWELL & MOORE, INC.

TULSA, OKLAHOMA

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more data on advertised products, use Readers' Service Cards, last page.

ON THE NOSE

PRECISE ALLOY MIX GIVES *extra life* TO CHASE® ANTIMONIAL ADMIRALTY HEAT EXCHANGER TUBES

Strange that such a simple little thing as weighing could add years of life to a heat exchanger tube. Yet this careful weighing, plus extra care in manufacture, is why Chase Antimonial Admiralty Heat Exchanger Tubes *do* last longer!

Thanks to this weighing process, Chase Antimonial Admiralty Heat Exchanger Tubes contain *exactly* the right combination of metals to resist the ravages of dezincification. As a result, Chase Antimonial Admiralty Heat Exchanger Tubes mean lower operating costs, fewer breakdowns, more time between tube replacements!

Next time you plan a new installation, or replace heat exchanger tubes, install Chase Antimonial Admiralty. Enjoy extra years of service!

CHASE WAREHOUSE STOCKS: Houston,* Los Angeles, New Orleans, Tulsa**

*Handled by Standard Brass & Mfg. Co. **Handled by Vinson Supply Co.

Chase®

BRASS & COPPER CO.

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

The Nation's Headquarters for Brass & Copper

Albany†	Chicago	Detroit	Los Angeles	New York	St. Louis
Atlanta	Cincinnati	Grand Rapids†	Milwaukee	Philadelphia	San Francisco
Baltimore	Cleveland	Houston	Minneapolis	Pittsburgh	Seattle
Boston	Dallas	Indianapolis	Newark	Providence	Waterbury
Charlotte†	Denver	Kansas City, Mo.	New Orleans	Rochester†	(†sales office only)

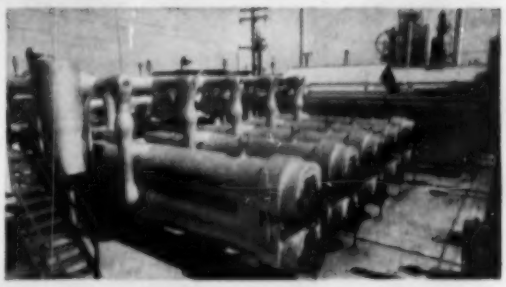
Designed for today's *Tough* service demands

DROP FORGED VALVES AND FITTINGS FOR TOUGHNESS AND TROUBLE-FREE SERVICE

Drop forged from carbon and alloy steels, Vogt valves, fittings and flanges will safely handle liquids and gases at high pressures and high temperatures in power plants, chemical plants, petroleum refineries, etc. The complete line includes flanged, screwed and socket weld end globe, gate and check valves—ells, tees, and crosses—couplings—bushings—plugs—unions—flanges and flange unions—and welding heads.

MODERN STEAM GENERATORS

Vogt steam generators are designed to give maximum rating in a minimum of space, with high efficiency and low maintenance expense. Bent tube types and straight tube, forged steel sectional header types to burn solid, liquid or gaseous fuels meet every power, process or heating requirement.



PROCESS EQUIPMENT FOR EVERY SERVICE

Vogt constructs process equipment in wide variety to all Codes. Stills and towers, oil chillers, crystallizers, heat exchangers, molding machines, etc., serve in the manufacture of oils, greases, 100 octane gasoline, synthetic rubber, chemicals and related products around the world.

SPECIAL MATERIALS COMBAT CORROSION AND PRODUCT CONTAMINATION

Our modern shops produce a wide variety of equipment from special metals and alloys to fight corrosion and product discoloration or contamination. Fabrication procedures insure that corrosion resistant properties of welds will match that of the materials used to construct the equipment.

Vogt

PRODUCTS

FOR REFINERIES, CHEMICAL PLANTS POWER PLANTS AND PROCESS INDUSTRIES

HENRY VOGT MACHINE CO.
LOUISVILLE 10, KY.

BRANCH OFFICES: New York, Philadelphia, Chicago, Cleveland St. Louis, Dallas, Charleston, W. Va.

MORE REFRIGERATION TONNAGE AT LESS COST

More than 70 years of engineering and manufacturing experience is incorporated in Vogt refrigerating and ice making equipment. Absorption Systems, Compression Systems, and Tube-Ice Machines in a wide range of capacities serve industrial and processing plants, and institutions, here and abroad.

For more data on advertised products, use Readers' Service Cards, last page.

Look at these exclusive design features of Cooling Sections, Structure and Drive!

G-R fin-fan
Air-Cooled
Heat Exchanger

1. G-R air-cooled exchanger design, construction and performance ratings are factual and guaranteed.

2. Performance records obtained from many millions of square feet of K-Fin cooling section elements.

3. Advanced designs of transfer surface, structure and drive mechanism.

4. K-Fin elements can be of the metal or alloy best suited to the particular fluids being handled.

5. K-Fin structure is strong and rugged—the same as used in over 15,000 G-R Bentube Sections.

Make sure you get *all* the advantages available in the G-R **fin-fan** Air-Cooled Exchanger. Investigate *now*.

THE GRISCOM-RUSSELL CO., MASSILLON, OHIO

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

GR-545

OVER

85

YEARS

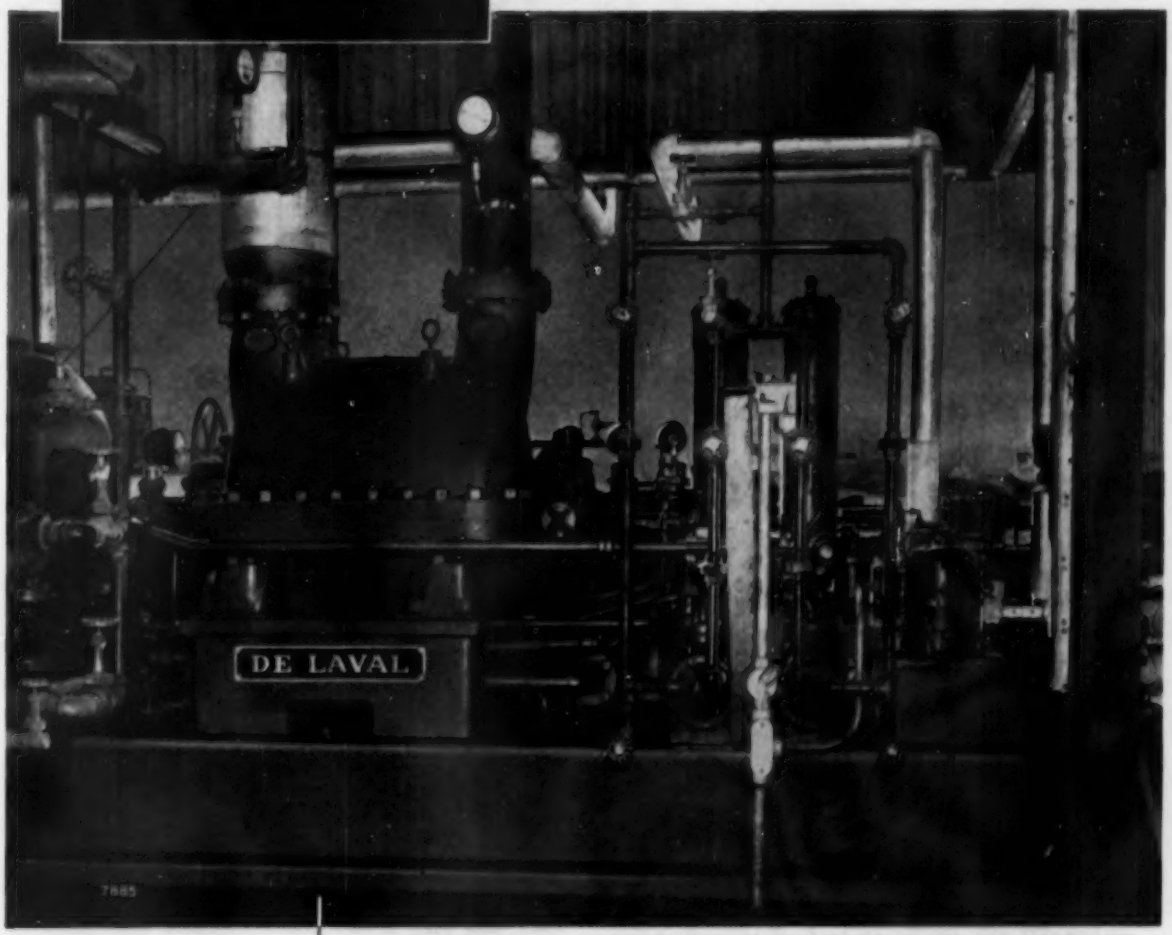
of heat transfer experience built into every

G-R fin-fan

G-R HEAT TRANSFER APPARATUS **fin-fan Air-Cooled Heat Exchanger**

DE LAVAL CENTRIFUGAL COMPRESSOR

handles propane-butane for M. W. Kellogg alkylation unit



New Bulletin 0504 gives complete data

On stream at a plant of a large mid-western refiner, this De Laval unit compresses the propane-butane mixture to prepare it for an M. W. Kellogg alkylation unit.

Inlet volume of the De Laval centrifugal compressor is 3,040 cubic feet per minute. Inlet pressure is 18 psia, and discharge pressure 85 psia. This compressor is equipped with De Laval contact-type oil seals. The unit is driven by a 600 bhp turbine running at 7,400 rpm.

De Laval compressors are designed and built for heavy duty continuous operation. Rugged, horizontally split casings, individually designed impellers, perfectly balanced rotors and externally mounted, cylindrically seated bearings assure optimum performance and long service.

DE LAVAL *Centrifugal Compressors*

DE LAVAL STEAM TURBINE COMPANY
811 Nottingham Way, Trenton 2, New Jersey

DL 209

Mr. Design Engineer

Mr. Purchasing Director

Mr. Plant Superintendent

BROWN FINTUBE DESIGN PROTECTS YOU AGAINST

YOUR *Occupational Hazard*

● If it hasn't happened to you yet,—it will. Beware!

Some day the company is going to decide to make a new product at your plant. The "market analysis and research" department will assure you the maximum requirement is so many thousand gallons a week. You'll design the plant . . . buy the equipment . . . get on stream . . . and then two or three months later — BOOM!

The market analysis boys "played it safe". Now — based on "newly available statistics"— they need 20% to 30% more output than the plant you just finished can possibly produce.

If you equipped that plant with "bundle" type exchangers you are going to have to wait, while you design — and fabricate — and install all new units. *And*, what are you going to do with the exchangers you just bought? Throw them away after only two or three months use?

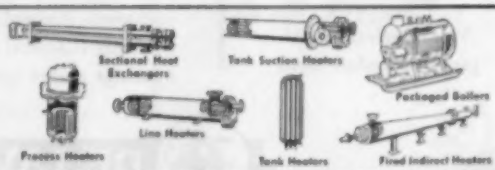
If you had used Brown Fintube Heat Exchanger **Sections** in that plant you would need only to add a few sections or change the series-parallel manifolding. You would be running on the new duty,— or even an entirely different product — in just a few days — with a **minimum of new equipment** — and **nothing to throw away.**

That's what we call **"flexibility"**. You can change from one duty to another any time you want. You can even dismantle an exchanger, ship the sections to one or three or four different plants, and put them right back in service again.

Many of the biggest, best known and lowest cost companies are keeping **flexible** by using Brown Fintube **Sections** throughout their plants. Why don't you play it safe too? Available with mild steel, stainless, alloy and non-ferrous fintubes — in standard sizes — for a wide range of capacities and pressures. Send for Bulletin No. 512. It gives full details. And plan on keeping your plant **flexible** with Brown Fintube **Sections.** They will really save you money!

BROWN FINTUBE CO.

370 HURON ST., *Elyria, Ohio*



Engineering and Sales Representatives: NEW YORK • BOSTON • PHILADELPHIA • PITTSBURGH • BUFFALO • CLEVELAND • CINCINNATI DETROIT • CHICAGO • ST. PAUL • ST. LOUIS • KANSAS CITY • MEMPHIS • BIRMINGHAM • NEW ORLEANS • SHREVEPORT • TULSA • HOUSTON • DALLAS DENVER • LOS ANGELES AND SAN FRANCISCO ● *Licensed Manufacturers:* BROWN FINTUBE (CANADA) LTD., ST. THOMAS, ONTARIO, CANADA BROWN FINTUBE (GREAT BRITAIN) LTD., BIRMINGHAM, ENGLAND • FRIEDRICH UHDE, GMBH, DORTMUND, GERMANY

The most compact, reliable sampler ever built . . .

THE NEW Gilbarco

Small in size...
light in weight

AUTOMATIC SAMPLER

Here's a new compact, completely automatic, magnetically powered and electronically controlled sampler designed to provide a continuous sample from process or pipe lines.

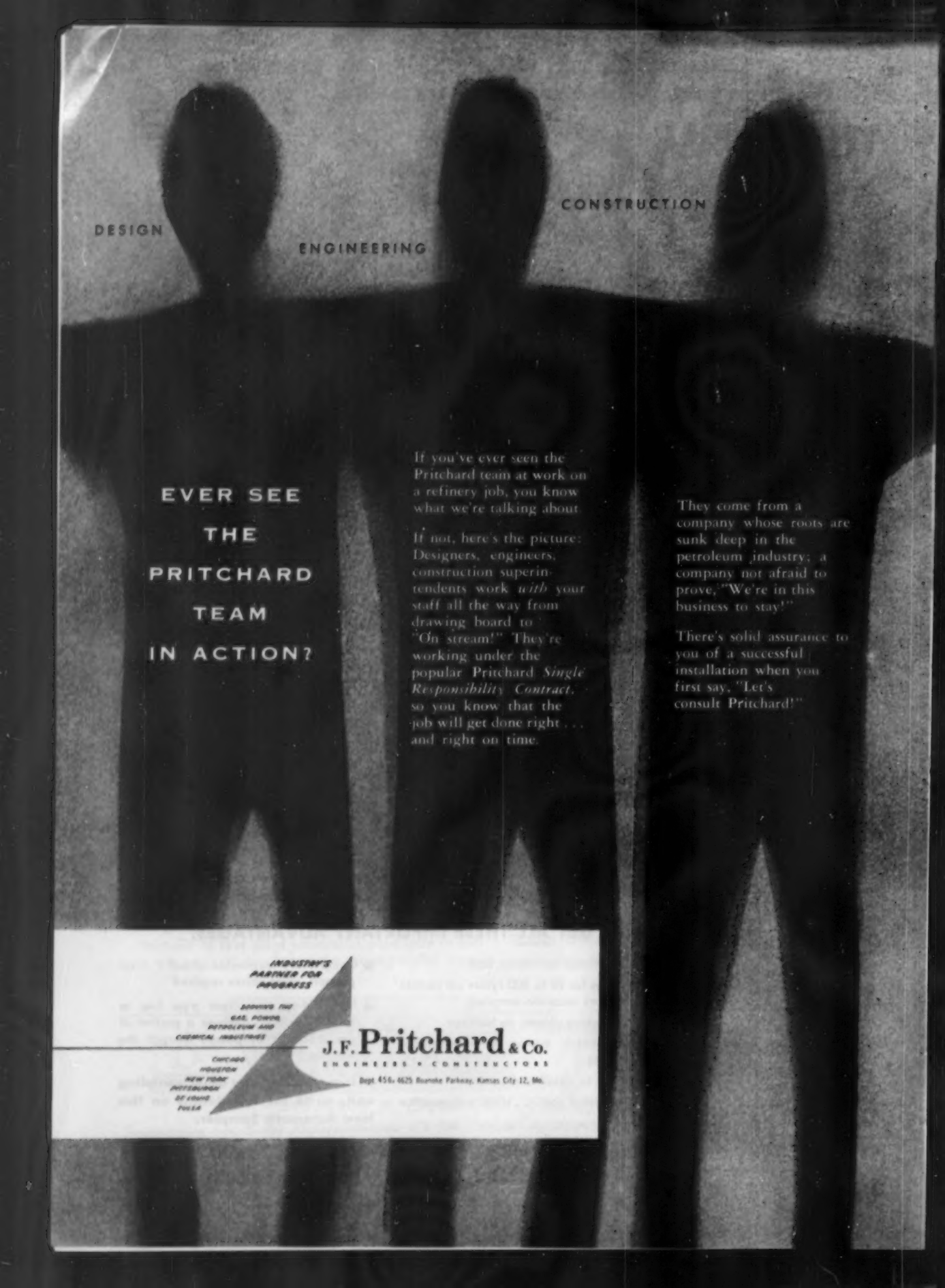
USERS GET ALL THESE IMPORTANT ADVANTAGES.

- ★ Proportional to time or flow
- ★ Settings for 20 to 300 cycles per minute for more accurate sampling
- ★ No packing glands, no leakage
- ★ No electric motor, no mechanical switches
- ★ Simple to install and service
- ★ LOW initial cost . . . LOW maintenance cost
- ★ Completely explosion-proof . . . no pressure relief valves required
- ★ No hold-up time from pipe line to sample receiver; because a portion of the stream is by-passed through the sampler

Before you buy any other sampling unit, write for full details on this New Automatic Sampler.

GILBERT & BARKER MFG. CO. • WEST SPRINGFIELD, MASS. • TORONTO, CANADA

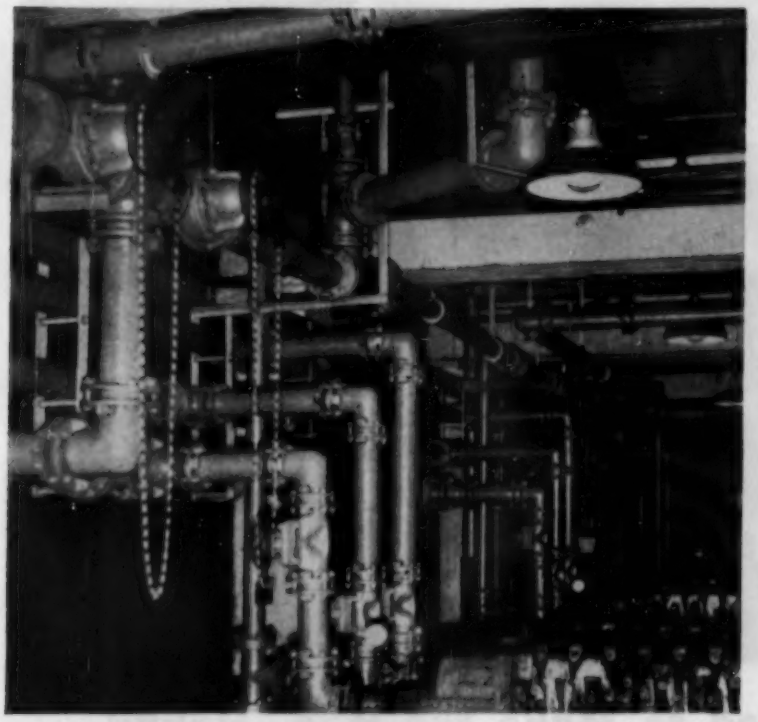
For more data on advertised products, use Readers' Service Cards, last page.


DESIGN
ENGINEERING
CONSTRUCTION
EVER SEE THE PRITCHARD TEAM IN ACTION?
If you've ever seen the Pritchard team at work on a refinery job, you know what we're talking about
If not, here's the picture: Designers, engineers, construction superintendents work *with* your staff all the way from drawing board to "On stream!" They're working under the popular Pritchard *Single Responsibility Contract*, so you know that the job will get done right . . . and right on time.
They come from a company whose roots are sunk deep in the petroleum industry; a company not afraid to prove, "We're in this business to stay!"
There's solid assurance to you of a successful installation when you first say, "Let's consult Pritchard!"
INDUSTRY'S PARTNER FOR PROGRESS
SERVING THE GAS, POWER, PETROLEUM AND CHEMICAL INDUSTRIES
CHICAGO
HOUSTON
NEW YORK
PITTSBURGH
ST. LOUIS
TULSA
J.F. Pritchard & Co.
ENGINEERS • CONSTRUCTORS
Dept. 456, 4625 Roanoke Parkway, Kansas City 12, Mo.

WHERE HAVEG EQUIPMENT IS INSTALLED

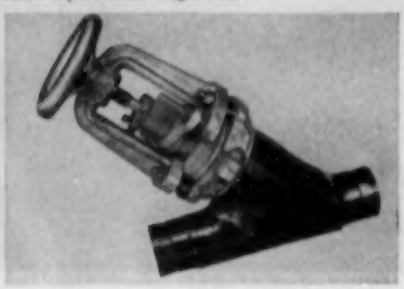
TRADE MARK REG. U. S. PAT. OFF.

PIPE • DUCT • FITTINGS • VALVES • PUMPS



A typical large installation of Haveg pipe, valves and fittings showing simple method of support required. Haveg pipe is unaffected by thermal shock, seldom requires insulation.

These Haveg parts are used in pumps for hot (104°F.) 30% Hydrochloric acid. Typical record: 33 months without replacing a single part. Many users report even longer life.



Escape potential valve troubles by buying Haveg y-valves and diaphragm valves which are smooth-molded, exactingly machined, tested in the Haveg factory. Haveg works with you on special designs!

Processing Corrosion has been Controlled!

Where liquids get hot and corrosive, it pays to consider all the facts about Haveg piping systems. Haveg has all the major ingredients for good chemical piping. Strength. Durability. Light weight. Outstanding resistance to corrosion and thermal shock.

It withstands rapid temperature changes and enables you to go into a high range of process temperatures with complete safety and a proven history of reliable performance. Haveg piping resists corrosion of practically all acids (except oxidizing acids) and lasts for years without repairs or maintenance.

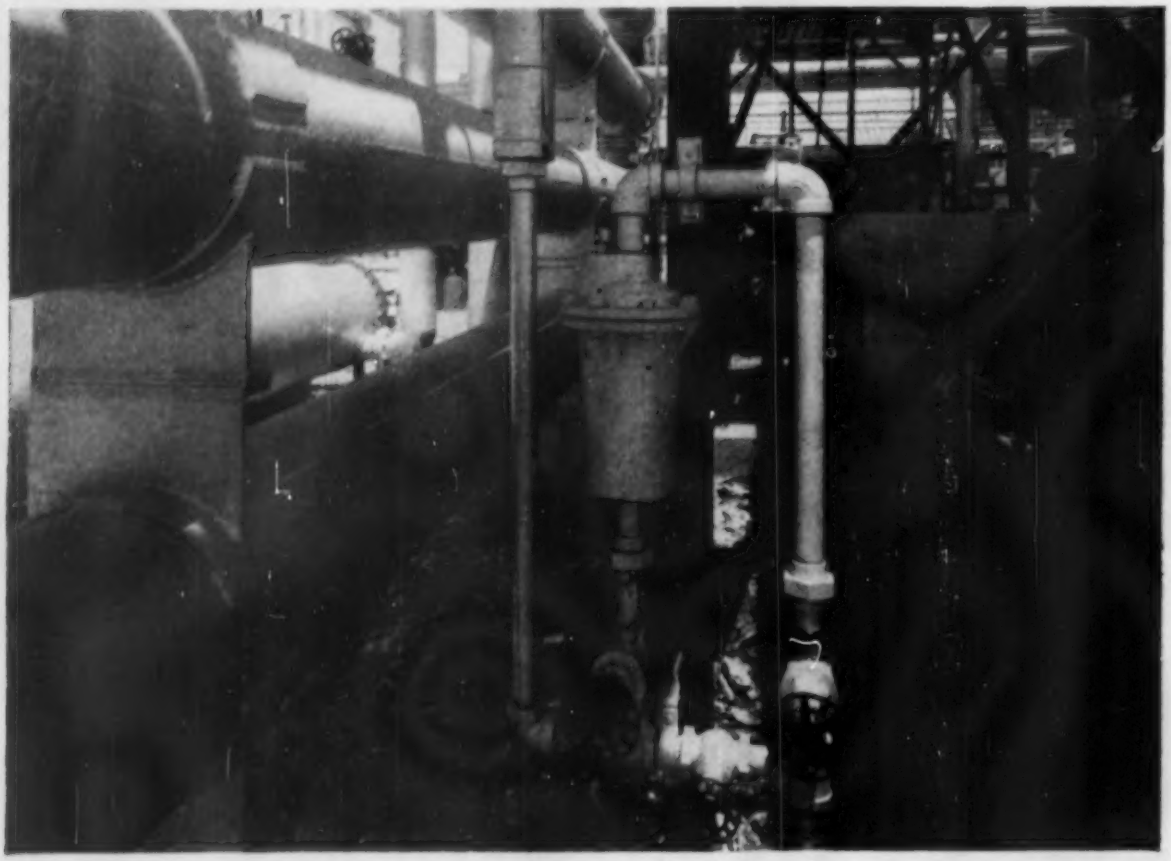
Haveg *piping* is molded in diameters of ½" up and comes in lengths to 10'. It can be cut and fitted on the job (a new Haveg tool makes this even simpler—ask your Haveg engineer for details). For handling corrosive gases or fumes, Haveg *duct* is made in cylindrical or rectangular shape with lighter walls. Fume hoods, bifurcators, fan housings, fittings, all are made from Haveg and give complete containment and control of corrosives.

It's a long story telling all about Haveg, the moldable, thermosetting plastic material made of acid-digested asbestos and synthetic resins. Haveg is both a material and a service . . . it comes from America's first molders of corrosion-resistant plastic equipment. It can be as big as a 200' stack, as small as a miniature pump part. Call the experienced sales engineer listed. Write for the 64-page illustrated Bulletin F-6 which contains size and chemical resistance charts, design specifications. Remember, Haveg is a logical, proven answer to your design problems in handling hot, corrosive liquids; in fact, in all equipment that must control processing corrosion.

ATLANTA, Exchange 3821 • CHICAGO 11, Delaware 7-6088
CINCINNATI 36, Sycamore 2600 • CLEVELAND 20, Washington 1-8700
DETROIT 39, Kenwood 1-1785 • HOUSTON 4, Jackson 6840
LOS ANGELES 14, Mutual 1105 • SEATTLE 7, Hemlock 1351
ST. LOUIS 17, Mission 5-1223 • WESTFIELD, N. J., Westfield 2-7383

HAVEG CORPORATION
NEWARK 4, DELAWARE
TRADE MARK REG. U. S. PAT. OFF.
FACTORY: WILMINGTON 8, DEL. • Wilmington 3-8884
A SUBSIDIARY OF CONTINENTAL-DIAMOND FIBRE CO.

For more data on advertised products, use Readers' Service Cards, last page.



A Trap Designed to Make the P. A. Happy*

P. A. States The Case. The Purchasing Director of a midwestern refinery says: *"The lowest price bid is sometimes not the most economical or desirable one. Often a proper evaluation of other factors reveals quite the contrary to be the case. What we are after is to obtain the lowest overall cost of operating units. Therefore, the first cost of any piece of equipment must be considered together with such other factors as maintenance, safety, durability, flexibility, etc."*

*On the above basis Armstrong traps are certainly designed to please the Purchasing Agent as well as the Superintendents, Engineers, Steamfitters and Maintenance Men:

Installation. Armstrong offers side inlet-side outlet or bottom inlet-top outlet traps in sizes up to 1¼" so hook-ups can be made with minimum labor and fittings. All traps can be equipped with internal check valves, and the three smallest sizes are available with integral strainers. These optional built-in features mean lower installation costs.

Durability. Valves and seats are file-hard chrome steel, ground and lapped together. The other parts are corrosion-resistant stainless steel. Mechanisms in low and medium pressure traps are identical in design, materials and workmanship to those used in traps for 900°F, 900 psig!

Maintenance. Armstrong traps seldom require maintenance. And, they are easily inspected or repaired simply by removing the cap to which the entire mechanism is connected. The body stays in the line. To make a trap new again, simply install a repair assembly straight from the factory production line.

Safety. Every fine-grained cast semi-steel trap is factory-tested at 500 W. S. P. For great resistance to fire, shock and explosion Armstrong offers a complete line of forged steel traps starting at only $20.00 list.

For lowest cost in the long run, Armstrong traps are your best buy. Call your nearby Armstrong Representative or write:

ARMSTRONG MACHINE WORKS
852 Maple Street, Three Rivers, Michigan

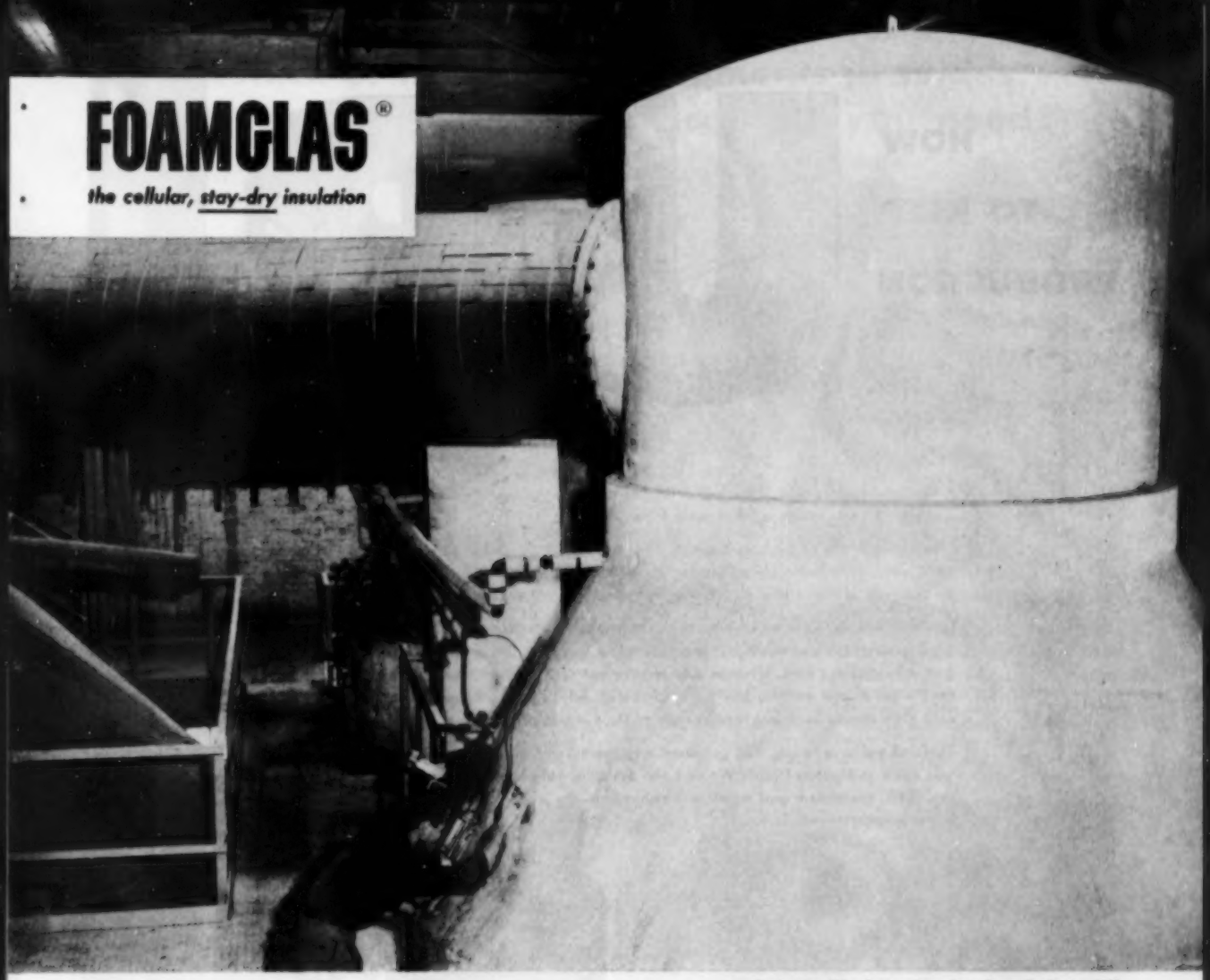
Application Engineered
ARMSTRONG STEAM TRAPS

ASK FOR CATALOG J
44-pages of trapping facts and figures, how-to-do-it data and useful information. Free on request.

565

FOAMGLAS®

the cellular, stay-dry insulation



Contractor: Wm. Summerhays Sons Corp., Rochester, N.Y.

FOAMGLAS insulation stays dry, effective and re-usable for International Salt

reports R. B. Richards, Chief Engineer, New York Evaporating Plants, International Salt Co., Inc.

"Our evaporation process requires an insulation that's high in both efficiency and strength," says Chief Engineer R. B. Richards, International Salt Company, Inc., Watkins Glen, N.Y. "That's why we picked FOAMGLAS to insulate our evaporating pans and piping."

Mr. Richards explains, "Moisture-proof FOAMGLAS stays dry and effectively prevents excessive heat loss which would upset the exact temperature-pressure balance our process requires.

"Also we're in the middle of a 4-year construction job, redesigning and renewing our entire evaporation system. Maintaining full production now calls for constant shifting of pipes and lines. The pre-cut shapes of FOAMGLAS are so strong and rigid that we are able to remove them, move the line and re-use the same pieces of insulation."

Pittsburgh Corning Corporation

One Gateway Center • Pittsburgh 22, Pa.

In Canada: 57 Bloor St. W., Toronto, Ontario

Like International Salt Co., producers of Sterling Salt, you too will benefit from the unique properties of this cellular glass insulation. Send the coupon right away.

Pittsburgh Corning Corporation, Dept. Z-55
One Gateway Center, Pittsburgh 22, Pa.

Please send me FOAMGLAS literature on the following:

- ☐ Building insulation
- ☐ Insulation for cold storage space
- ☐ Pipe insulation
- ☐ Insulation for tanks and other equipment
- ☐ Send free sample of FOAMGLAS
- ☐ Send engineer to discuss a specific insulating problem

NAME _____

COMPANY _____ TITLE _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

HOW TO KEEP PRODUCTION UP!

A few generations ago, John Ruskin had a few penetrating remarks to register on business—and what he said makes a lot of sense today.

"The common law of business practice," he commented, "prohibits paying a little and getting a lot. If you deal with the lowest bidder, it's well to add something for the risk you run. And if you do that, you will have enough left over for something better."

Let's translate this in terms of furnace construction for refineries. If you buy a heat enclosure for a job where high and continuous production is a must, then it's imperative that you invest in one that will stand the gaff. To make sure, you've got to build a unit which is properly engineered for the job it must do. You pay more, of course. But it's poor economy—and often embarrassing—to plow money back into repairs right at the peak of production.

That's all we have to say. You get sound engineering and a job designed to stay on stream when you come to Bigelow-Liptak. We've been designing refinery furnaces for years—erecting them, too. Both suspended and castable construction—the one that's best for the job—are used. Better investigate—right now!

FIRST COST OF AN INFERIOR JOB

PLUS REPAIRS AND LOST PRODUCTION

FIRST COST OF A BIGELOW-LIPTAK JOB

BIGELOW-LIPTAK *Corporation*

AND BIGELOW-LIPTAK EXPORT CORPORATION
2550 WEST GRAND BOULEVARD, DETROIT 8, MICHIGAN

UNIT-SUSPENDED WALLS AND ARCHES

In Canada: BIGELOW-LIPTAK OF CANADA, LTD., *Toronto, Ontario*

ATLANTA • BOSTON • BUFFALO • CHICAGO • CLEVELAND • DENVER • HOUSTON • KANSAS CITY, MO. • LOS ANGELES • MINNEAPOLIS • NEW YORK
PHILADELPHIA • PITTSBURGH • PORTLAND, ORE • ST LOUIS • ST PAUL • SALT LAKE CITY • SAN FRANCISCO • SEATTLE • TULSA • VANCOUVER, B. C.

For more data on advertised products, use Readers' Service Cards, last page.

Which of these two instruments provides the temperature control accuracy you need?

1. IT'S ELECTRONIC! The new Series 560 applies the thermistor principle in temperature indicator controls with heretofore unattainable accuracy over a scale range of 200° to 600°F. It's the *only* instrument that provides the three major control modes — (1) on-off (2) proportional (3) adjustable differential — all at the flip of a switch. Wide range of use for general laboratory, processing, molding or packaging applications.

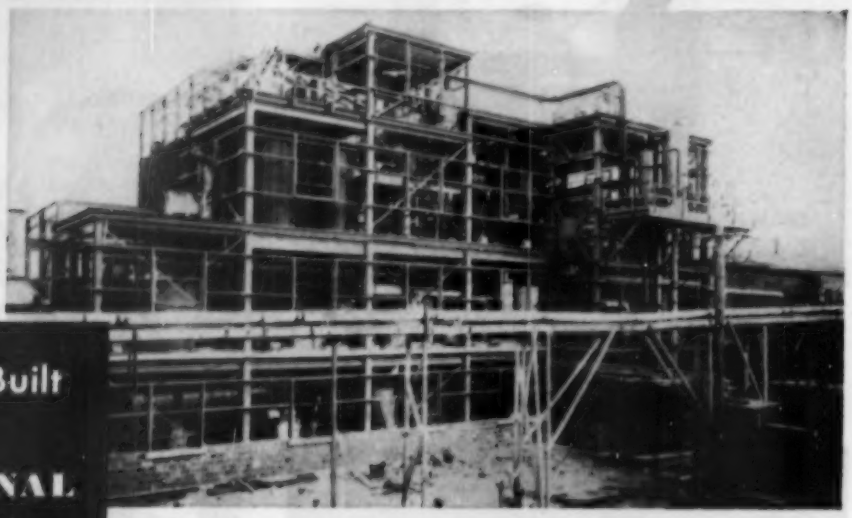
2. IT'S MECHANICAL! The new Series 540 indicating controller combines low cost with high accuracy over a temperature range of 100° to 700°F. Temperature changes are transmitted by a bulb and bellows to an indicator control. Instrument features on-off control . . . adjustable differential . . . ambient compensation. May be flush or surface mounted. Capacity of 15 amps at 115 volts.

3. SIMPLICITY ITSELF is secret of Fenwal's Series 560 — accuracy, sensitivity and ruggedness. The thermistor's high resistance change permits operation with any length of lead wire up to 200 feet without affecting signal strength or accuracy. Thermistor is hermetically sealed in glass for stability; encased in stainless steel for ruggedness. No complex circuitry; maintenance is easy.

4. EASY "SET" AND "CHECK" OPERATION is a feature of Fenwal's Series 540 which is accurate to within 2% over the 100° to 700°F range, including the effects of ambient temperatures. Send for FREE NEW BULLETINS, MC122 on the Series 540, MC123 on the Series 560. Both contain full data you should have. Write to **Fenwal Incorporated, 105 Pleasant St., Ashland, Mass.**

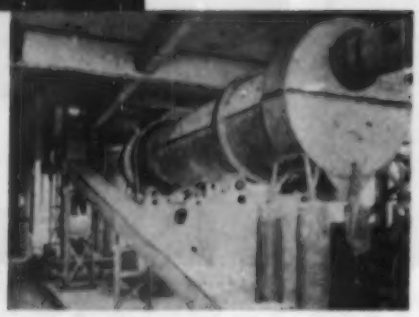
Fenwal Controls Temperature . . . *Precisely*

MODERN KOH PLANT



Designed and Built for INTERNATIONAL MINERALS & CHEMICAL CORPORATION Niagara Falls, N. Y.

for Inorganic Chemicals Manufacture

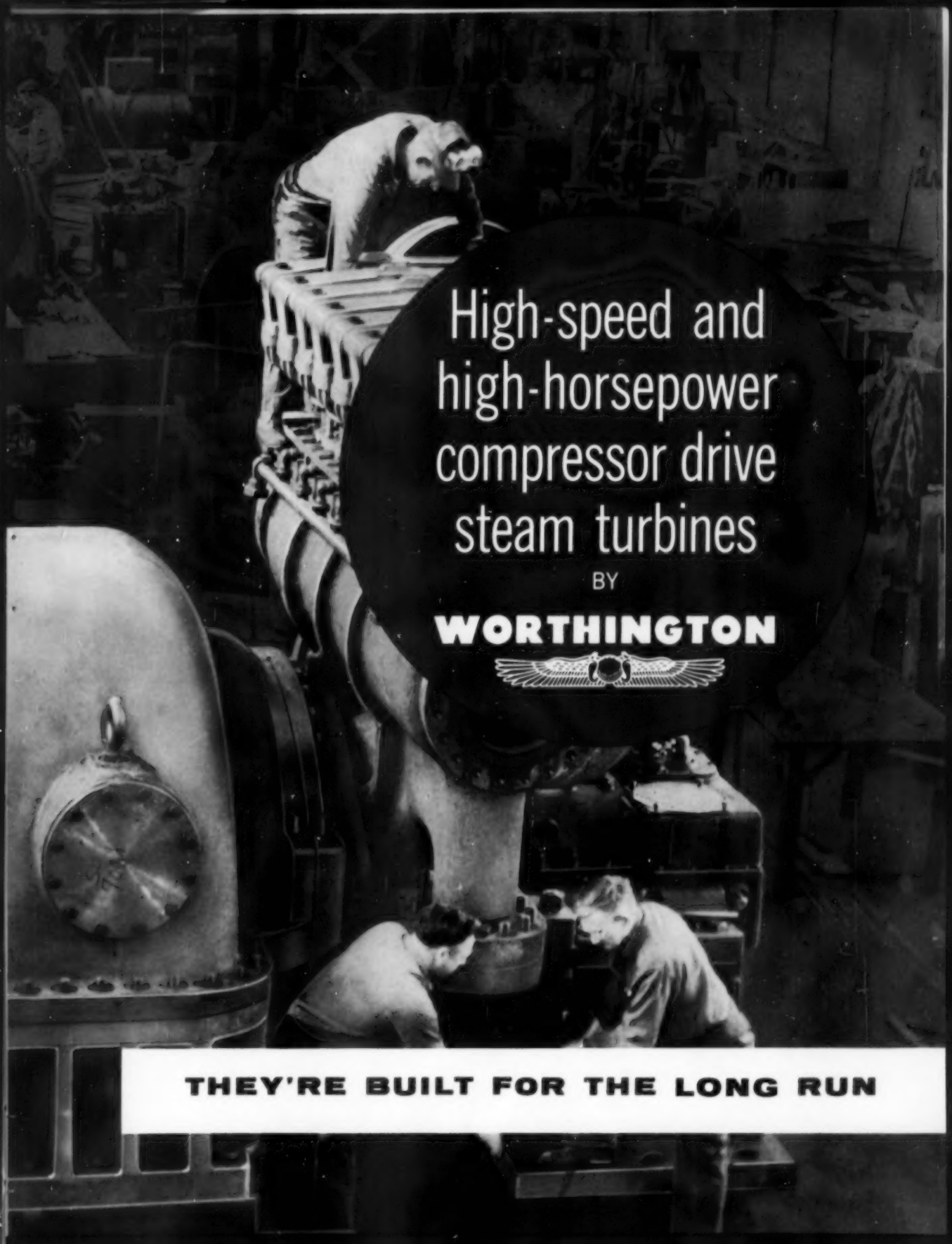


The best impression of the finished plant can be obtained at this stage of the project with the "heart of the plant" yet visible. Our engineering and construction work on this project have been completed and the plant is now in successful operation.

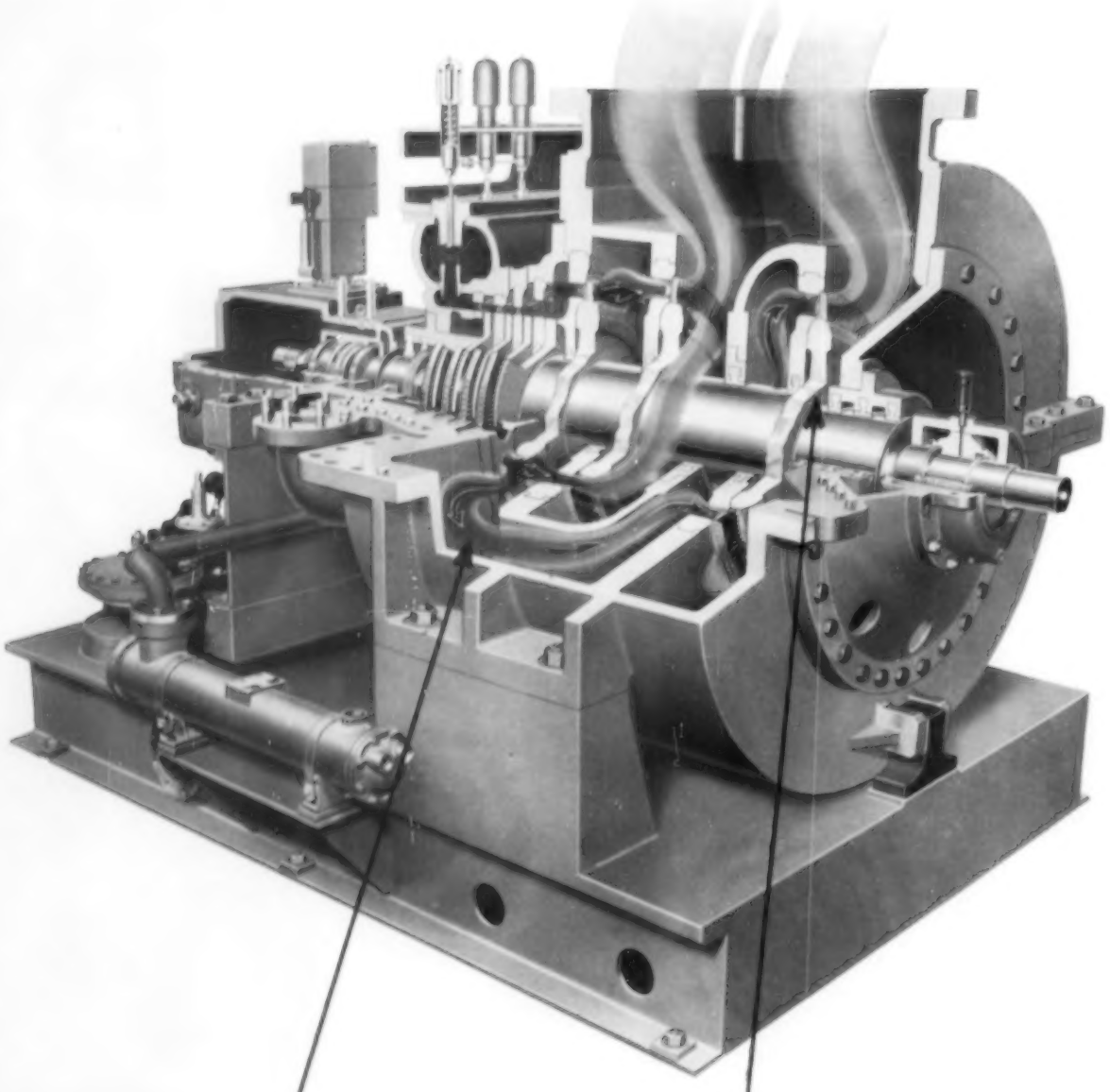
Engineering Services include Design and Construction of Complete Process Plant Projects and Individual Process Units, Process Evaluation, and Economic Studies.

BADGER · MANUFACTURING COMPANY

230 BENT STREET, CAMBRIDGE 41, MASS. 60 EAST 42nd STREET, NEW YORK 17, N.Y.


High-speed and
high-horsepower
compressor drive
steam turbines
BY
WORTHINGTON
THEY'RE BUILT FOR THE LONG RUN

HIGH-SPEED TURBINES For DRIVING . .



DOUBLE-FLOW EXHAUST CONSTRUCTION. When you need it, this construction is supplied. By directing half the steam through one set of blades, and the other half through another set of blades, wheel size and blade length are significantly reduced. This lessens danger of extreme stresses and eliminates necessity for complicated blade design.

SOLID ROTOR (wheels forged integral with shaft) used on all Worthington High-Speed Turbines is naturally stronger, eliminates the need for a wide wheel hub, permitting a more conservative and lighter design. Extra benefit: it also decreases turbine's length — simplifying critical speed problems.

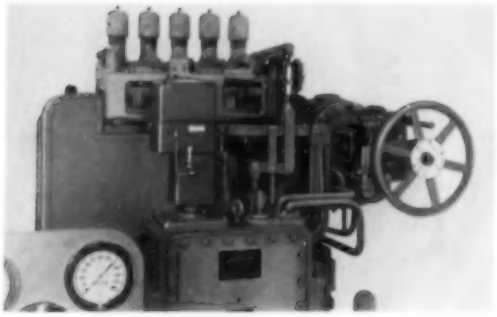
THINK FURTHER THAN FIRST COST

. . ANY CENTRIFUGAL COMPRESSOR

No matter what make of compressor or blower you buy, you can get a Worthington Turbine specifically designed to fit.

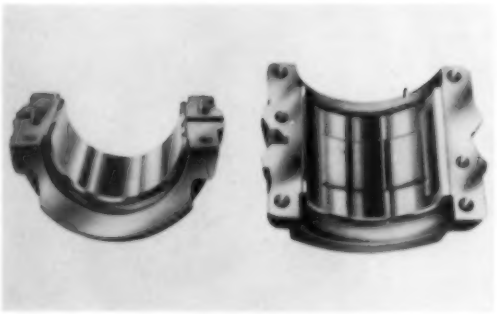
EXPERIENCE + SPECIAL DEVELOPMENTS

= TROUBLE-FREE OPERATION

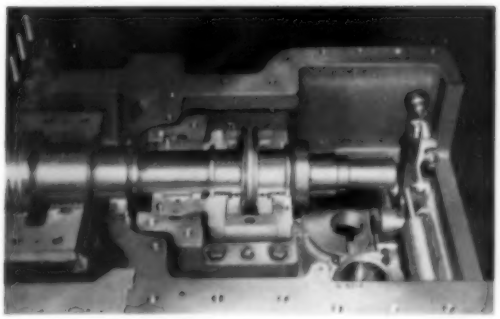


3 EXAMPLES

WOODWARD GOVERNOR WITH BUILT-IN AIR HEAD. Air motor operates directly on governor speed changer spring. Result: turbine is *always* under control of speed governor for *any* setting of air motor. Tendency for speed changes due to variations in steam conditions is automatically compensated for *before* affecting the compressor.



HIGH-SPEED ANTI-OIL-WHIP BEARINGS are machined with dead-end groove in top half in which pressure builds up to force journal downward at all times. This overcomes shaft's natural tendency to climb in the bearing — which would result in whipping at high speeds. High lube pressure assures smooth operation at all times.



SINGLE COLLAR KINGSBURY-TYPE THRUST BEARING on Worthington Steam Turbines permits high speeds with small friction losses. The single collar also enables journal bearing to be placed closer to turbine casing — reducing bearing span while keeping all parts of thrust bearing away from hot steam parts.

WORTHINGTON

SPECIFY WORTHINGTON TURBINES FOR RELIABILITY

You're in good company when you go WORTHINGTON!

Well over 60 of the world's major Petroleum and Chemical companies — the BIG names — depend on literally hundreds of Worthington high-speed compressor and blower turbine drives . . .

And Remember:

- **QUALITY CONSTRUCTION** . . . gives you the most for your turbine dollar.
- **ENGINEERING KNOW HOW** . . . assures the right turbine for your compressor drive up to 24,000 hp or 12,000 rpm.
- **SKILLED CRAFTSMANSHIP** . . . for reliable, trouble-free operation.
- **UNPARALLELED EXPERIENCE** . . . in all industries using steam turbines to drive centrifugal compressors.

- **More facts about Worthington High-Speed Turbines are in our bulletin 1966. Write for it today.**

Worthington Corporation
Section 24T.5.2
Harrison, New Jersey

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When production depends on steam turbines buy the best — buy WORTHINGTON

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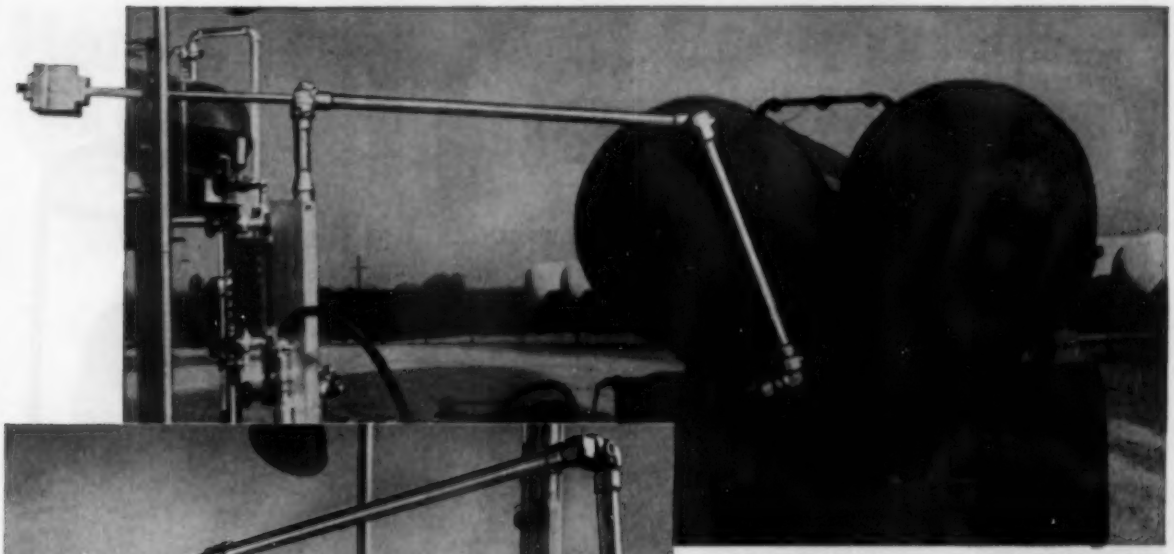


The truck loading rack illustrated here is made up of one 2", Style 50, one Style 40, one Style 50 x 5 high pressure steel Chiksan swivel joints, and one 1" Style 20 high pressure steel joint.

This truck loading rack in an Oklahoma gas company plant is manifolded so it can either load highly volatile Butane or Propane with complete flexibility and safety.

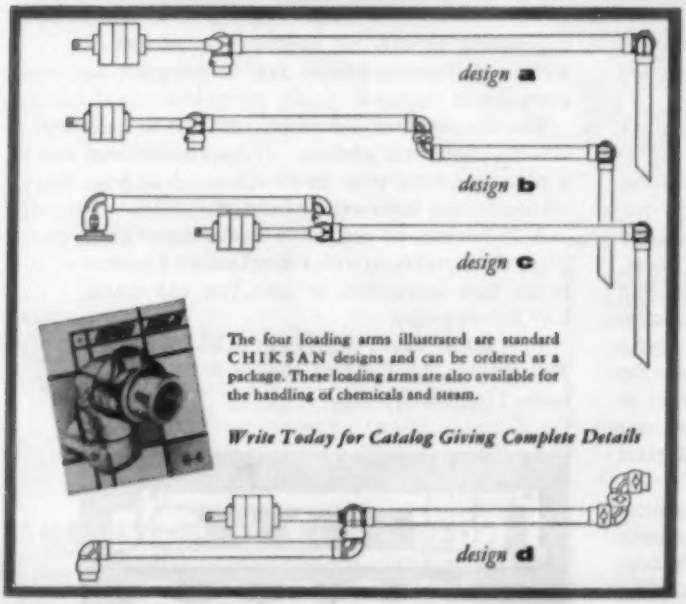
CHIKSAN adds Safety and Speed to Truck or Tank Car Loading of Gas or Chemicals

CHIKSAN provides the necessary liquid-tight, gas-tight connections, the characteristic flexibility of motion to keep volatile Butane and Propane or chemicals flowing swiftly with safety, economy and convenience.

Loading and unloading lines made up with dependable CHIKSAN ball-bearing swivel joints provide a wide margin of safety by using the same materials used throughout the pipe lines.

Any required degree of flexibility is provided, simply by arranging CHIKSAN ball-bearing swivel joints in proper sequence. Total length of any arm is governed by the required length of pipe sections between swivels. Whether it be a standard design loading arm or a special design for a specific problem, write CHIKSAN today, the nature of your requirements.

Write to Dept. PR-5 for Catalog giving complete detailed information.



The four loading arms illustrated are standard CHIKSAN designs and can be ordered as a package. These loading arms are also available for the handling of chemicals and steam.

Write Today for Catalog Giving Complete Details

The Flow of Enterprise Relies on

CHIKSAN

Ball-Bearing Swivel Joints

CHIKSAN COMPANY • BREA, CALIFORNIA • Chicago 3, Illinois • Newark 2, New Jersey

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Co., Brea, Calif.; Newark 2, N. J. • Chiksan of Canada Ltd., Edmonton, Alta.

BETZ • *A Great Name In Water Conditioning*

"Prescriptions" by the truckload!

Solving industrial water conditioning problems effectively and *economically* requires exacting engineering techniques.

There are no stock answers . . . no stock chemical treatments.

We realize this perhaps more than anyone. In fact, we make a business of it.

For example, each year at our mixing and formulating plants in Pennsylvania, Texas, California, and Quebec, we blend and ship thousands upon thousands of different "prescriptions", each specifically job-engineered to solve some individual water conditioning problem for industry. Because we feel it is so important to "tailor-make" our formulations, each of our plants actually performs the function of a giant industrial pharmacy.

The blending and shipment of our chemical formulations is, however, only one important part of our *completely-individualized* water conditioning service. Individual investigations, plant control methods, daily testing programs, periodic checkups, analyses of water samples, and regular engineering reports all combine to provide a water conditioning service that is complete in every detail.

The end result of individual attention to individual problems is obvious . . . the assurance of a plant (perhaps your own) operating at peak efficiency, free from water problems.

A 20-minute, no obligation discussion of your plant water problems with a Betz District Engineer is the best investment in time you can make. Call him in today.

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Contains the Most Up-to-date Information on:

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METHYLENE CHLORIDE

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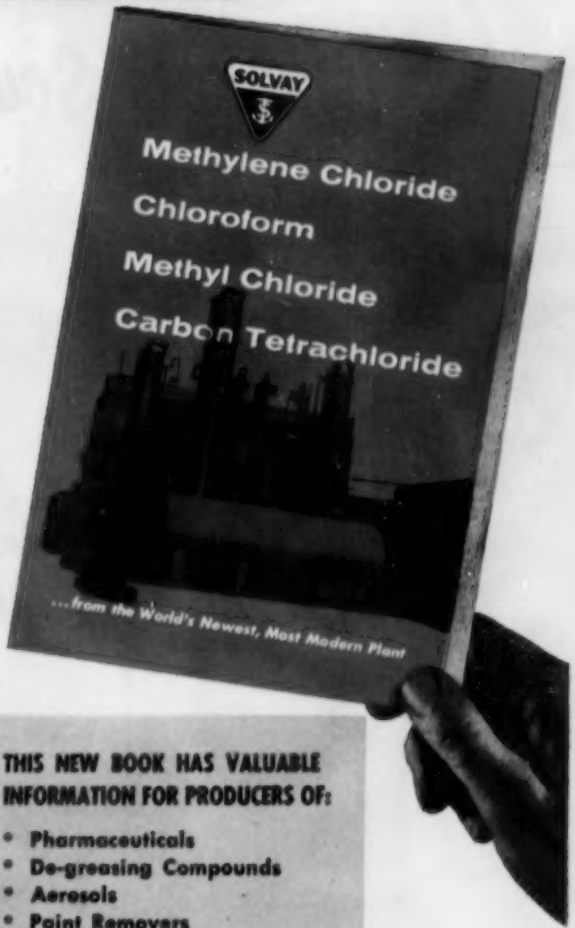

This 28-page book gives detailed physical and chemical properties of Solvay Chloromethanes . . . *plus* the latest charts, research material, azeotrope tables, and data on the use, handling and storage of these chemicals.

We will be glad to send you a copy of this new booklet without cost or obligation.* In addition, if you will write, giving us details of your operations, we will be glad to tell you how Solvay Chloromethanes can be used to the best advantage. All information sent us will be kept in strictest confidence. Mail coupon for your free copy of the book today.

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Para-dichlorobenzene • Methylene Chloride
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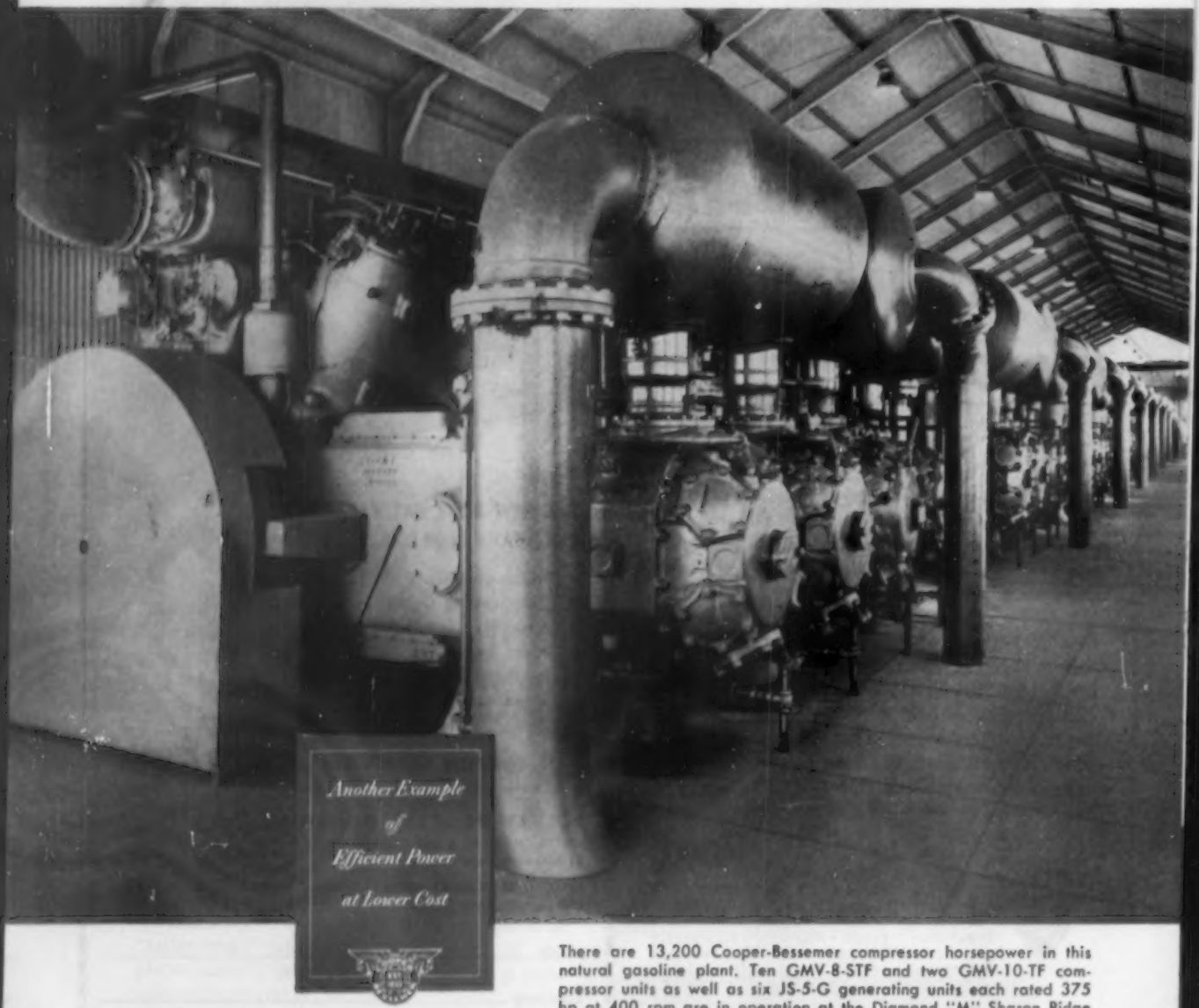
For more data on advertised products, use Readers' Service Cards, last page.

42,730 Cooper-Bessemer Horsepower Blankets Scurry County



There are 13,200 Cooper-Bessemer compressor horsepower in this natural gasoline plant. Ten GMV-8-STF and two GMV-10-TF compressor units as well as six JS-5-G generating units each rated 375 hp at 400 rpm are in operation at the Diamond "M" Sharon Ridge Gasoline Plant operated by the Lion Oil Company.

COMPRESSORS-GAS ENGINES-DIESELS

New York Washington, D. C. Bradford, Pa.

San Francisco, Cal. Houston, Dallas, Greggton, Pampa and Odessa, Texas Seattle, Wash.

The Snyder Gasoline Plant operated by Sunray Oil Corporation. In this, the largest Cooper-Bessemer powered plant in Scurry County, operating conditions are handled by twelve 1350 horsepower compressors. Also in operation are four JS-8-GTF engines rated 715 hp at 450 rpm.

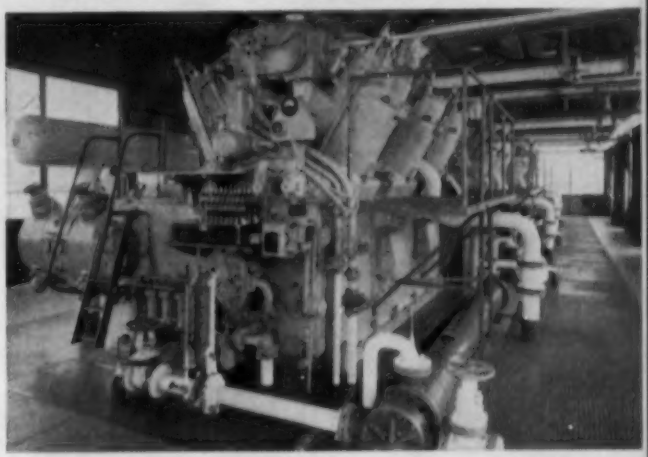
The Fuller Gasoline plant, operated by The Texas Company, contains five 880 hp GMV-8-TF units and three 110 hp GMV-10-TF units. In addition, three Cooper-Bessemer JS-8-GTF gas engines drive generators which provide electrical power.

In the rich Scurry County oil and gas field, more and more Cooper-Bessemer horsepower has been added through the years, comprising an enviable record of top quality performance at low operating expense.

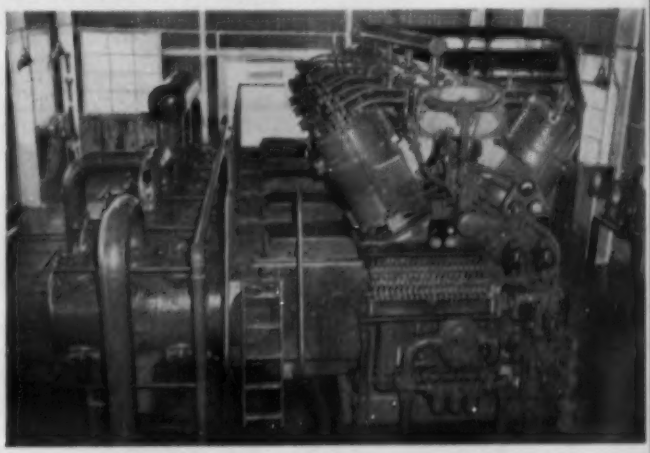
Engine driven compressor units for gas gathering, gas transmission, and various types of gas engines for driving auxiliaries and electric generators are only a few of the many jobs being capably handled by Cooper-Bessemers in this Texas area.

Such well-known organizations as El Paso Natural Gas Company, Lion Oil Company, Lone Star Gas Company, Sunray Oil Company and The Texas Company have installed Cooper-Bessemer units to meet their power requirements in Scurry County.

If you have compressor or generating problems, consult your nearest Cooper-Bessemer office. For compactness, efficiency, long service life, minimum supervision, and low installation and maintenance costs, you can't top Cooper-Bessemer.



Four Cooper-Besemer GMV-6-TF gas engines in El Paso Natural Gas Company's Snyder, Texas, gas booster station. Each unit is equipped to provide proper unloading to permit flexibility in meeting changing pressure conditions.



A compact 10-cylinder Cooper-Bessemer compressor operating at the Lone Star Gas Company's Scurry County plant. As in all Scurry County installations pictured here, efficient service with low maintenance is assured when you install Cooper-Bessemer.

by **Cooper-Bessemer**

MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

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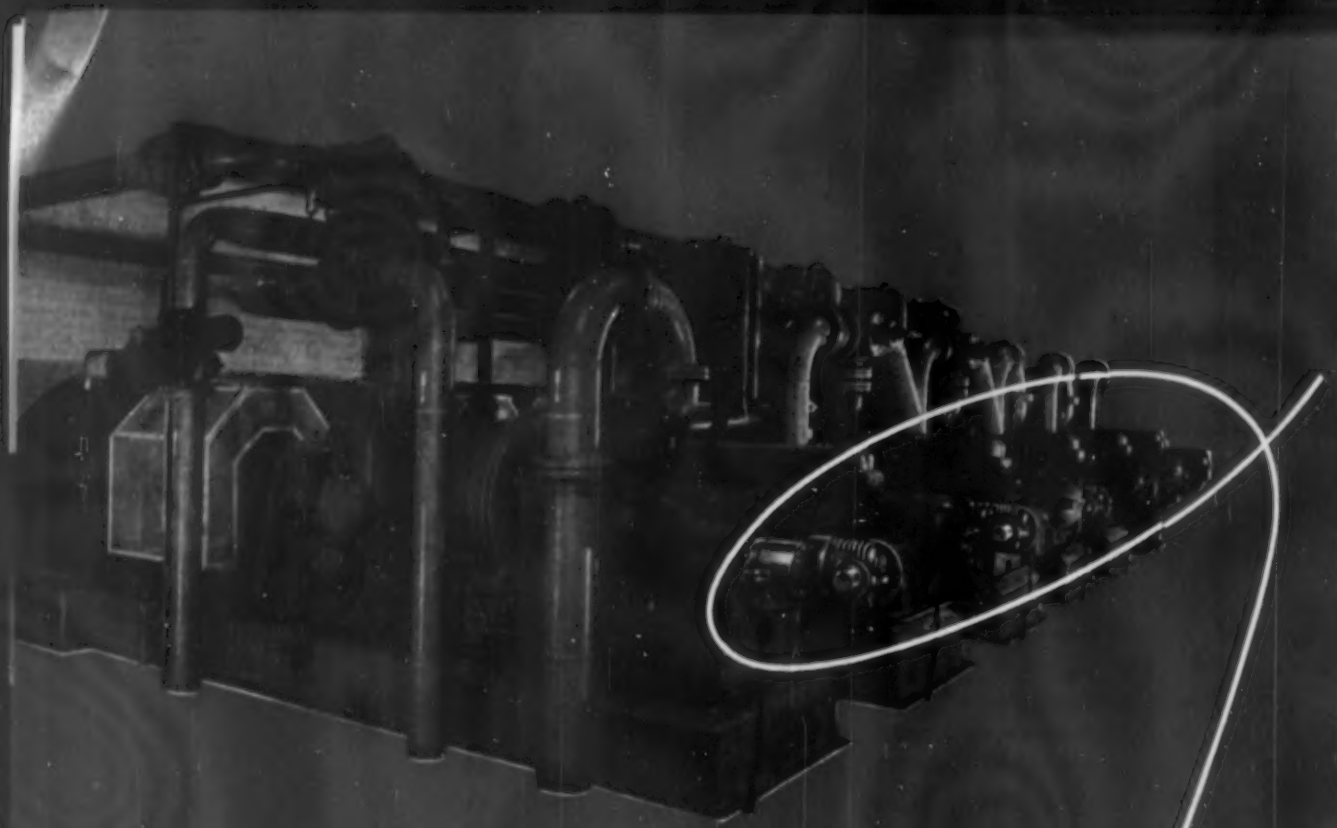
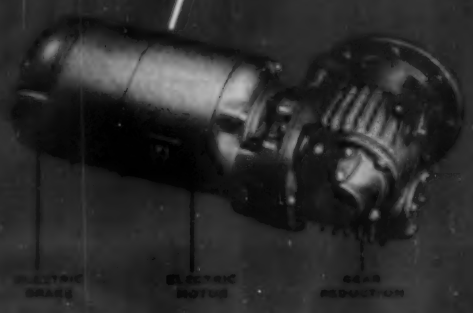


you can't beat them for compact slo-speed power

When you must have slow speed power, always consider first MASTER Right Angle Shaft Gearmotors. They're very compact . . . low in cost . . . safe . . . and so easy to use.

And nowhere else can you get anywhere near the wide range of selection that you have in MASTER Right Angle Gearmotors. They're available in sizes ⅛ to 25 Horsepower for all electrical specifications and in splash-proof, enclosed or explosion-proof construction. Gear reduction ranges up to 430 to 1 with the countershaft in either horizontal or vertical positions. In addition these gearmotors can be supplied with integrally built electric brakes . . . three types of variable speed units . . . and with fluid drive units for cushioned power.

Try them . . . you'll find they're the horsesense way to get slow-speed horsepower.



THE MASTER ELECTRIC COMPANY

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Dependable

Struthers Wells

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A complete line of Mixers designed for handling everything from the

THINNEST LIQUIDS to the THICKEST DOUGHS

Struthers Wells builds a complete line of Mixing Equipment for every purpose, including liquid agitators, hydrogenators, kneading machines and intensive mixers. Our extensive machine shops, plate fabricating facilities, forging equipment—combined with years of experience in the design of Mixing Equipment make Struthers Wells one of the foremost suppliers of this type of equipment.

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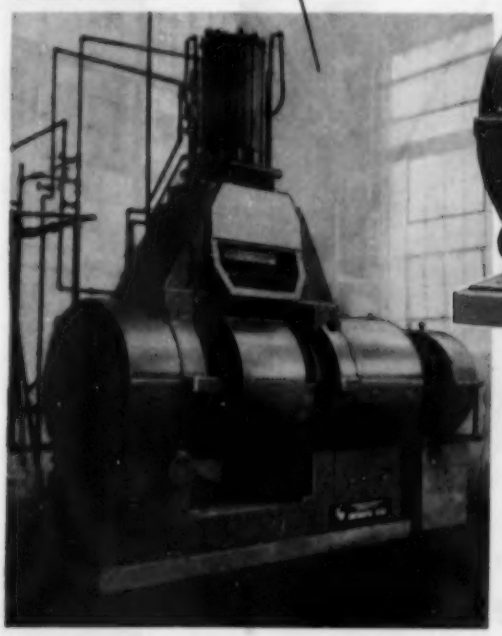
Equipped with patented Radial Propellers is suitable for hydrogenation and mixing a wide range of liquids. Any materials that will flow while being mixed can be handled under vacuum, low or high pressure with heating and cooling when required.

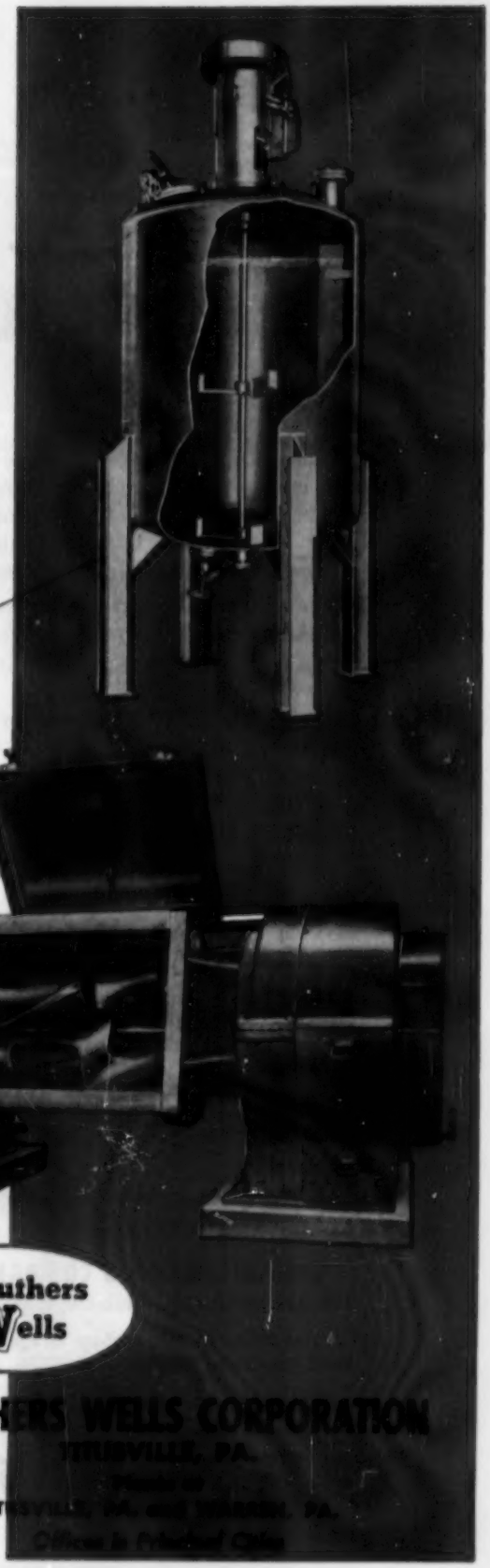
KNEADING MACHINE

Made in several types, Struthers Wells Kneading Machines are used for mixing stiff pastes. Some models may be rotated to a full inverted position for discharging.

INTENSIVE MIXER

Extremely powerful, Struthers Wells Intensive Mixers are suitable for processing plastics, rubber, asphalt tile and similar materials.





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STRUTHERS WELLS CORPORATION

TITUSVILLE, PA.

Write for literature on equipment for your mixing requirements

IT FLOATS ON THE LOAD! *

You turn on the steam.

This little stainless steel valve—the only moving part in the Yarway Impulse Steam Trap installed on the equipment—opens wide and *stays* open as the air and condensate continuously pour through.

The equipment reaches production temperature in the quickest possible time.

Production temperature reached, the little valve snaps shut. After that, by a pulsating action, it discharges all condensate as it forms—even a tiny teaspoonful. *There's hot steam in the equipment all the time . . .* steady, maximum temperatures are maintained.

It all adds up—to more production per day.

Other profit-making features of the Yarway Impulse Steam Trap—low initial cost, easy installation, stainless steel construction, low maintenance, good for all pressures, quick delivery from over 200 local industrial distributors.

Try a Yarway—free for 60 days—and *prove* its advantage. Your distributor will supply you.

For free Yarway Impulse Steam Trap Bulletin T-1740, write . . .

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* . . . *resulting in fast heat-up of equipment, more production per day.*

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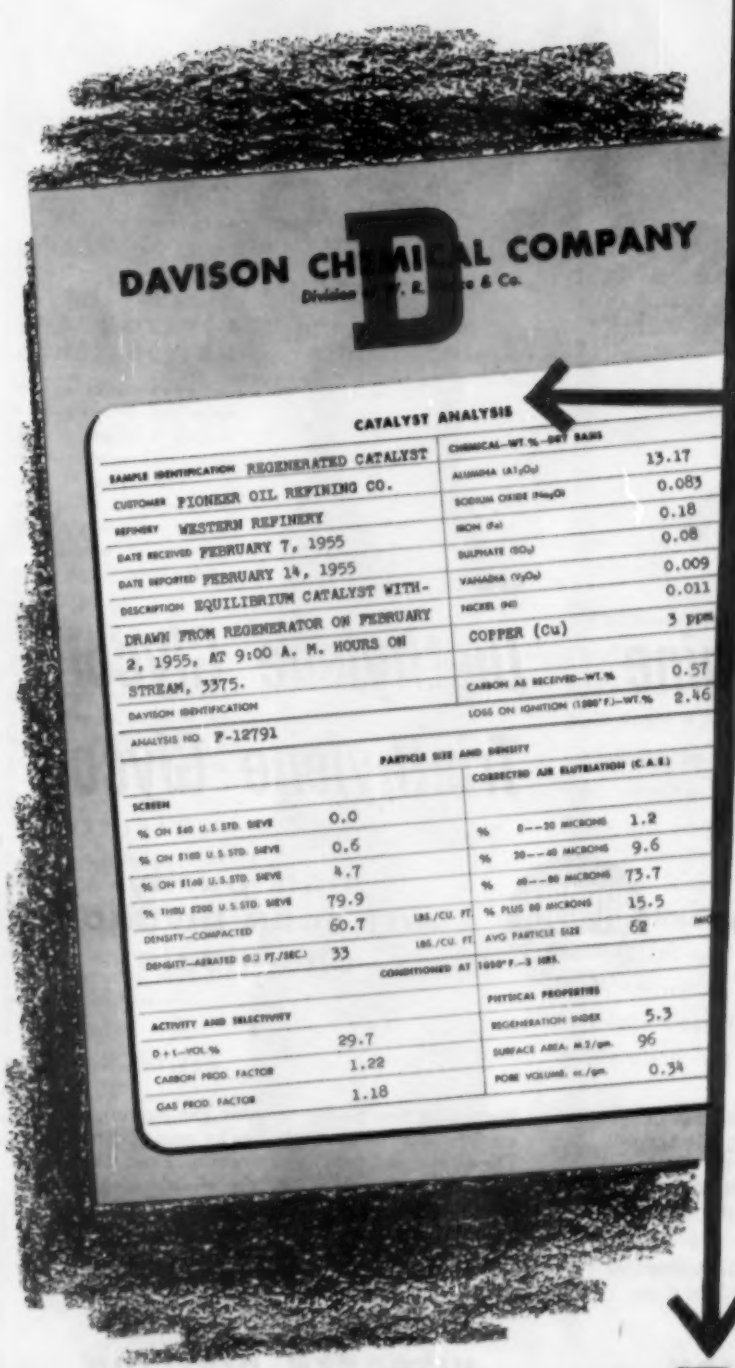
DAVISON CHEMICAL COMPANY
CATALYST ANALYSIS
SAMPLE IDENTIFICATION REGENERATED CATALYST
CUSTOMER PIONEER OIL REFINING CO.
REFINERY WESTERN REFINERY
DATE RECEIVED FEBRUARY 7, 1955
DATE REPORTED FEBRUARY 14, 1955
DESCRIPTION EQUILIBRIUM CATALYST WITH-
DRAWN FROM REGENERATOR ON FEBRUARY
2, 1955, AT 9:00 A. M. HOURS ON
STREAM, 3375.
DAVISON IDENTIFICATION
ANALYSIS NO. F-12791
CHEMICAL—WT. %—DRY BASIS
ALUMINA (Al_2O_3) 13.17
SODIUM OXIDE (Na_2O) 0.083
IRON (Fe) 0.18
SULPHATE (SO_4) 0.08
VANADIA (V_2O_5) 0.009
NICKEL (Ni) 0.011
COPPER (Cu) 3 ppm
CARBON AS RECEIVED—WT. % 0.57
LOSS ON IGNITION (1000° F.)—WT. % 2.46
PARTICLE SIZE AND DENSITY
SCREEN
% ON 140 U.S. STD. SIEVE 0.0
% ON 2100 U.S. STD. SIEVE 0.6
% ON 2100 U.S. STD. SIEVE 4.7
% THRU 2200 U.S. STD. SIEVE 79.9
DENSITY—COMPACTED 60.7 LBS./CU. FT.
DENSITY—AERATED (0.2 FT./SEC.) 33 LBS./CU. FT.
CORRECTED AIR ELUTRIATION (C.A.E.)
% 0—20 MICRONS 1.2
% 20—40 MICRONS 9.6
% 40—80 MICRONS 73.7
% PLUS 80 MICRONS 15.5
AVG. PARTICLE SIZE 62 MICRONS
CONDITIONED AT 1050° F.—3 HRS.
ACTIVITY AND SELECTIVITY
D + L—VOL. % 29.7
CARBON PROD. FACTOR 1.22
GAS PROD. FACTOR 1.18
PHYSICAL PROPERTIES
REGENERATION INDEX 5.3
SURFACE AREA: M.2/gm. 96
PORE VOLUME: cc./gm. 0.34

With catalysts it is the actual performance that is important.

A guide to this performance is to keep a constant check on the characteristics of the catalysts in your units. Realizing the importance of this, Davison maintains modern laboratories for analyzing equilibrium catalyst samples. Refinery experienced engineers regularly evaluate and report on the significance of these data. This is a regular Davison service given to Davison catalyst customers at no cost to the refiner.

For additional information on this service and Davison's M-S® catalyst, the most widely used synthetic cracking catalyst, see your Davison representative.

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Division of W. R. Grace & Co.

Baltimore 3, Maryland

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For more data on advertised products, use Readers' Service Cards, last page.

to remove

H_2S

CO_2

use

Monoethanolamine

Diethanolamine

high purity
NITROGEN DIVISION
chemicals

Maximize the purity of your gas stream, and minimize corrosion problems by using Nitrogen Division gas-treating chemicals. Free of unwanted chemical impurities — chlorides and acids — these products are consistently above standard purity specifications.

Call or write today for samples and quotations. Ask too for technical service to help adapt these high purity chemicals to your process.

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to remove

H_2O

use

Diethylene Glycol

Triethylene Glycol

high purity
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chemicals

Maximize the purity of your gas stream, and minimize corrosion problems by using Nitrogen Division gas-treating chemicals. Free of unwanted chemical impurities — chlorides and acids — these products are consistently above standard purity specifications.

Call or write today for samples and quotations. Ask too for technical service to help adapt these high purity chemicals to your process.

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Hopewell, Va. • Ironton, Ohio • Orange, Tex. • Omaha, Neb.

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Ethanolamines • Ethylene Oxide • Ethylene Glycols • Formaldehyde • Nitrogen Tetroxide
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Engineering Plus

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Here is an economical refractory liner for steel cased units. It involves a minimum of labor and provides a maximum of protection over a wide range of temperature. There is a refractory tile surface backed by insulation and a poured sealing layer.

THINSULITE

Construction provides more refractory and insulation which may be varied to suit the unit. Available with 3 and 4½ inch depths of tile.

DETEGRAL

Construction provides tile depths of 7 or 9 inches for more severe furnace conditions . . . backed by variable depths of insulation . . . plus a casing cement for weatherproof exterior finish.

SEVERAL OTHER

Constructions to meet different operating conditions are described in the booklet.

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There is a Detrick construction designed to meet any combination of combustion conditions in any type of refinery unit . . . from a complex catalyst regenerator, heater or boiler to a simple flue or breeching. In every case the proper materials and methods of application are selected to meet working conditions.

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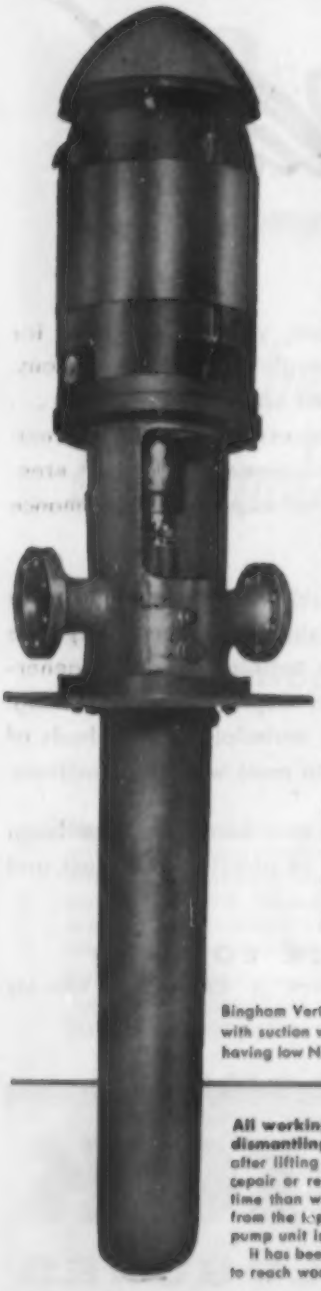
For more data on advertised products, use Readers' Service Cards, last page.

NEW! Bingham ALL WORKING PARTS



Besides bottom dismantling, which in itself greatly reduces maintenance time when attention is required, this new Bingham pump incorporates advanced design features which minimize maintenance, reducing the need for periodic inspection.

For example, all intermediate bearings (supplied of appropriate material for different pumpages) are forced-lubricated by the pumpage. Diagram at right shows this feature and, in addition, shows how bottom bearing is lubricated even if the pump runs dry for short periods. This *dependable* lubrication greatly prolongs the life of bearings, which in conventional pumps are frequently the cause of maintenance shutdowns.

Wherever it has been installed, the new Bingham VCP Pump has given trouble-free service—plus unsurpassed smooth operation with no vibration. Available for any capacity or head. Write your nearest Bingham office for additional information.

Bingham Vertical VCP assembled with suction well for installations having low NPSH conditions.

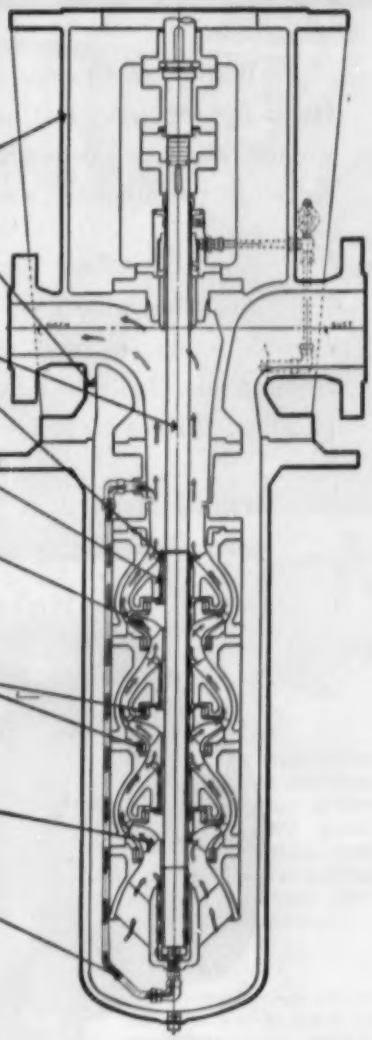
All working parts of pump easily accessible with bottom dismantling. One man can service the Bingham VCP Pump after lifting pump from well. By dismantling from the bottom, repair or replacement of any part can be made in much less time than with conventional pumps (where dismantling begins from the top, necessitating removal of driver and head before pump unit is accessible).

It has been estimated by various operators that time required to reach working parts has been reduced as much as 50%.

VCP VERTICAL PUMP FOR LOW NPSH
ACCESSIBLE WITH BOTTOM DISMANTLING

ONLY *Bingham* OFFERS ALL THESE BENEFITS:

1. Heavy-duty steel suction and discharge head rigidly built to eliminate vibration caused by drivers.
2. Shaft is maximum diameter throughout.
3. Shafts are equipped with renewable 11-13 chrome, hardened, ground and polished sleeves at each bearing.
4. Bearings are of the appropriate material for the different pumpages.
5. Maximum head per stage and maximum efficiency for a given capacity range.
6. Front and back wearing rings on enclosed type impellers permit a one-stage pressure drop over each bearing for lubrication purposes.
7. Wear rings reduce thrust of rotating element, permitting use of standard motors.
8. Maximum eye area of bottom impeller for lowest possible NPSH.
9. Bottom bearing lubricated by pumpage taken from the discharge column, which, together with connecting pipe, acts as a reservoir for bearing lubrication in event pump operates "dry" for short periods.



Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCED

BINGHAM PUMP COMPANY
General Offices: 2800 N.W. Front Avenue, Portland 10, Oregon
Factories: Portland, Ore. • Vancouver, B.C., Canada

SALES AND SERVICE OFFICES

BOSTON, MASS.	PITTSBURGH, PA.
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For more data on advertised products, use Readers' Service Cards, last page.

WILFLEY
ACID PUMPS

for HCl

$FeCl_2$

$CuCl_2$

NaOH

KCl

H_2SO_4

and other solutions

Wilfley Acid Pump

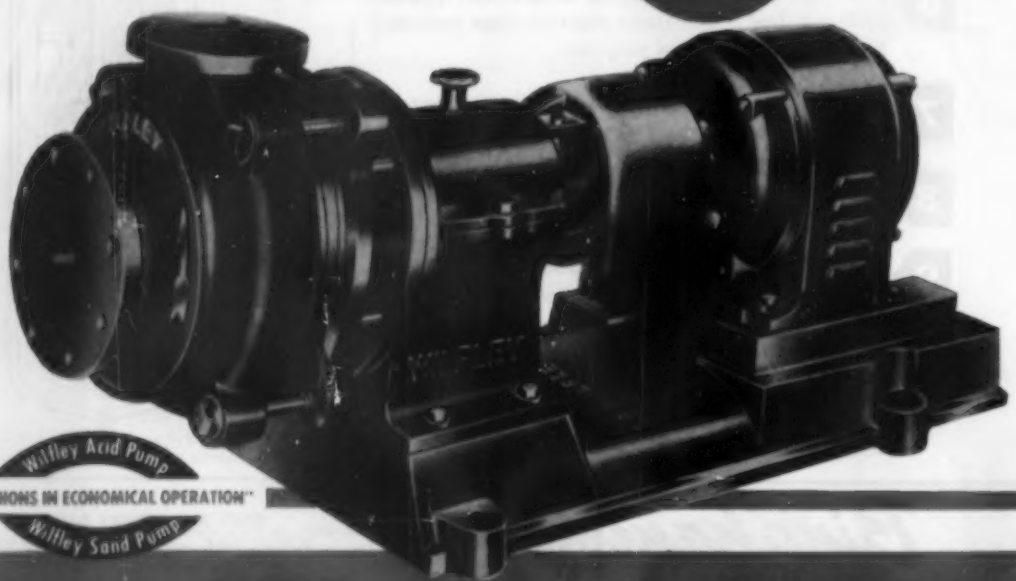
"COMPANIONS IN ECONOMICAL OPERATION"

Wilfley Sand Pump

Wilfley Acid Pumps have the enviable reputation for efficiency and economy. They operate without attention, delivering trouble-free, cost-reducing performance on "'round-the-clock" schedules.

Available with pumping parts of the machinable alloys, as well as plastic, to meet all requirements. Individual engineering on every application. Write or wire for complete details.

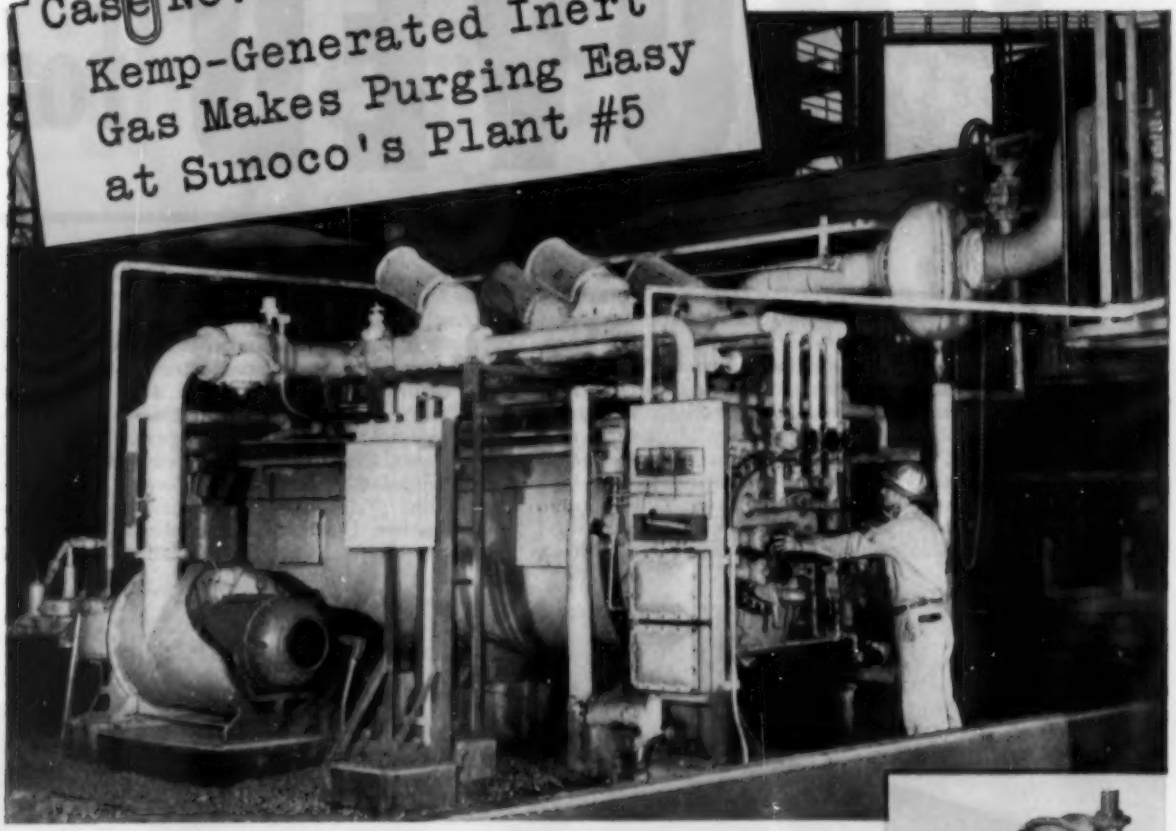
Wilfley Model "AF" Pump with wetted parts of durable, corrosion-resistant plastics.



A. R. WILFLEY & SONS INC., DENVER, COLORADO, U.S.A.

NEW YORK OFFICE: 1775 BROADWAY, NEW YORK CITY

Case No. 57
Kemp-Generated Inert Gas Makes Purging Easy at Sunoco's Plant #5



How Sun Oil's "Magic Mill" at Toledo operates with 'round the clock safety

There's no *one* word that strikes terror in the hearts of oilmen everywhere more quickly than F-I-R-E! To combat this threat at the Sun Oil Co.'s giant refinery at Toledo, Ohio, constant vigilance, checks and inspections are the answer. And the liberal use of inert gas for purging pipelines, tanks and crackers is essential to this safety maintenance.

Kemp selected to do the job

When plans called for *doubling* plant production in 1950, a new Kemp Generator (see above) was installed to insure adequate inert gas production. Fast-starting, easy-to-operate, this Kemp unit more than filled the bill. Today tanks and lines are periodically purged for inspection and cleaning *as often as needed*. And thanks to its 60,000 cu. ft. per hr. Kemp Inert Gas Generator, Sunoco enjoys *exact analysis* inert production that meets all its purging requirements.

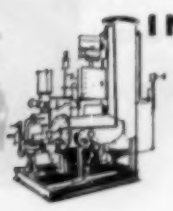
Let Kemp help you, too

If you have a purging or blanketing problem, why not let Kemp Engineers give you the same helpful advice used so profitably at Sun Oil's Toledo refinery. It costs you nothing to investigate. And it may save you money. Find out how Kemp's wide range of dependable, low-cost Generators (complete with the latest fire checks and safety devices) offer you the best way to solve your problems.

Photo above shows close-up view of Kemp Industrial Carburetor, the heart of every Kemp installation. Assures complete combustion... without waste, without tinkering. Reduces installation costs, simplifies maintenance.

For more complete facts and technical information, write for Bulletin I-10 to C. M. KEMP MFG. CO., 405 E. Oliver Street, Baltimore 2, Maryland.

KEMP OF BALTIMORE



INERT GAS GENERATORS

CARBURETORS • BURNERS • FIRE CHECKS METAL MELTING UNITS • ADSORPTIVE DRYERS • SINGEING EQUIPMENT

For more data on advertised products, use Readers' Service Cards, last page.

PROVED for

● Certainly, centrifugal compressors are practical for high pressure applications. Clark has been building them for years.

Installations on pipelines, in chemical processing plants, wind tunnels, catalytic reforming and field repressuring have *proved* Clark high pressure "centrifugals" to be entirely dependable and practical. Clark-proved design features make pressures up to 2500 psi completely feasible!

For moderately high pressures, Clark builds horizontally split cases for greatest accessibility. Available in either cast semi-steel or cast steel, with either up or down connections to fit your piping requirements, these cases are ideally suited to high pressures because of their compact, rugged construction. Cast-in, integral bearings assure permanent, built-in alignment, without the use of a costly fabricated base.

For pressures beyond the range of horizontally split cases, Clark builds vertically split, barrel-type units of either cast or forged steel construction.

In either Clark design, sealing—*of prime importance to any high pressure centrifugal*

Clark Horizontally Split Case
Pressures to 900 psi

Clark sets the pace
in compressor progress

CLARK

high pressure applications

compressor — presents no problem. Dependable, proved, oil seals *originated by Clark* hold the gas in the case where it belongs. Many parts, including the seals, are interchangeable between the two compressor designs.

Where extremely high ratios are encountered, the Clark design lends itself readily to drive-thru. Two or more cases can be driven by a single turbine or motor for maximum installation and operating economy.

Clark experience in handling practically all gases from hydrogen to butane, in a vast number of applications, is a real time and money-saver by eliminating the need for performance-testing. Only a mechanical test is required. Clark *knows* the performance of its machines.

For complete information, consult your nearest Clark representatives and request Bulletin 116.

CLARK BROS. CO. • OLEAN, N. Y.

ONE OF THE DRESSER INDUSTRIES

Sales Offices in Principal Cities Throughout the World

Clark Vertically Split Case
Pressures to 2500 psi

75

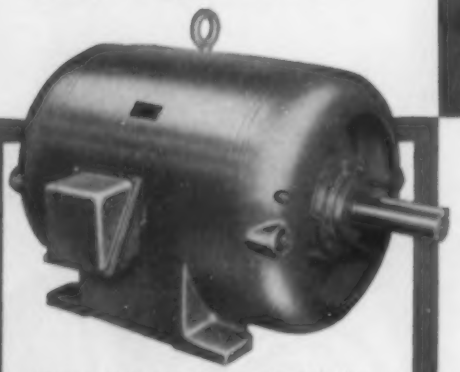
MULTI-STAGE

centrifugal compressors

For more data on advertised products, use Readers' Service Cards, last page.

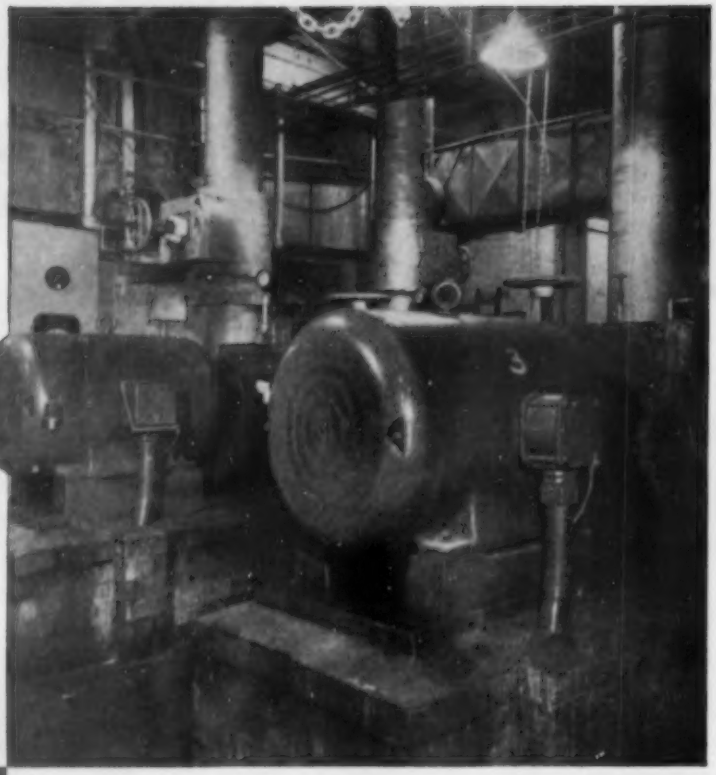
Wagner®
ELECTRIC MOTORS
...the choice of leaders in industry

use
WAGNER
Cast Iron Frame
Motors for
EXTRA PROTECTION
in corrosive
atmospheres



Type EP, totally-enclosed fan-cooled. Available in ratings from 2 to 250 hp.

Type JP, non-ventilated. Explosion-proof. ½ through 1½ hp.



These 150 hp Wagner Cast Iron Frame Motors drive brine pumps in an acid area at Celanese Corporation's Rock Hill, S. C. plant.

If the motors in your plant are subjected to corrosive fumes and liquids, Wagner Cast Iron Frame Motors will provide the *extra protection* you need.

These stock motors are totally-enclosed in corrosion-resistant cast iron. All parts exposed to the atmosphere are fabricated of corrosion-resistant material—even the nameplate. Features include completely protected laminations . . . special varnish treated windings . . . a running shaft seal.

Wagner Cast Iron Frame Motors are available in fan-cooled standard and explosion-proof types in ratings from 2 to 250 hp, and in non-ventilated standard and explosion-proof types in ratings from ½ through 1½ hp. Wagner Bulletin MU-132 gives complete information.

A skilled Wagner engineer will help you select the Wagner Motor to meet your most exacting specifications. Call the nearest of our 32 branch offices, or write us.

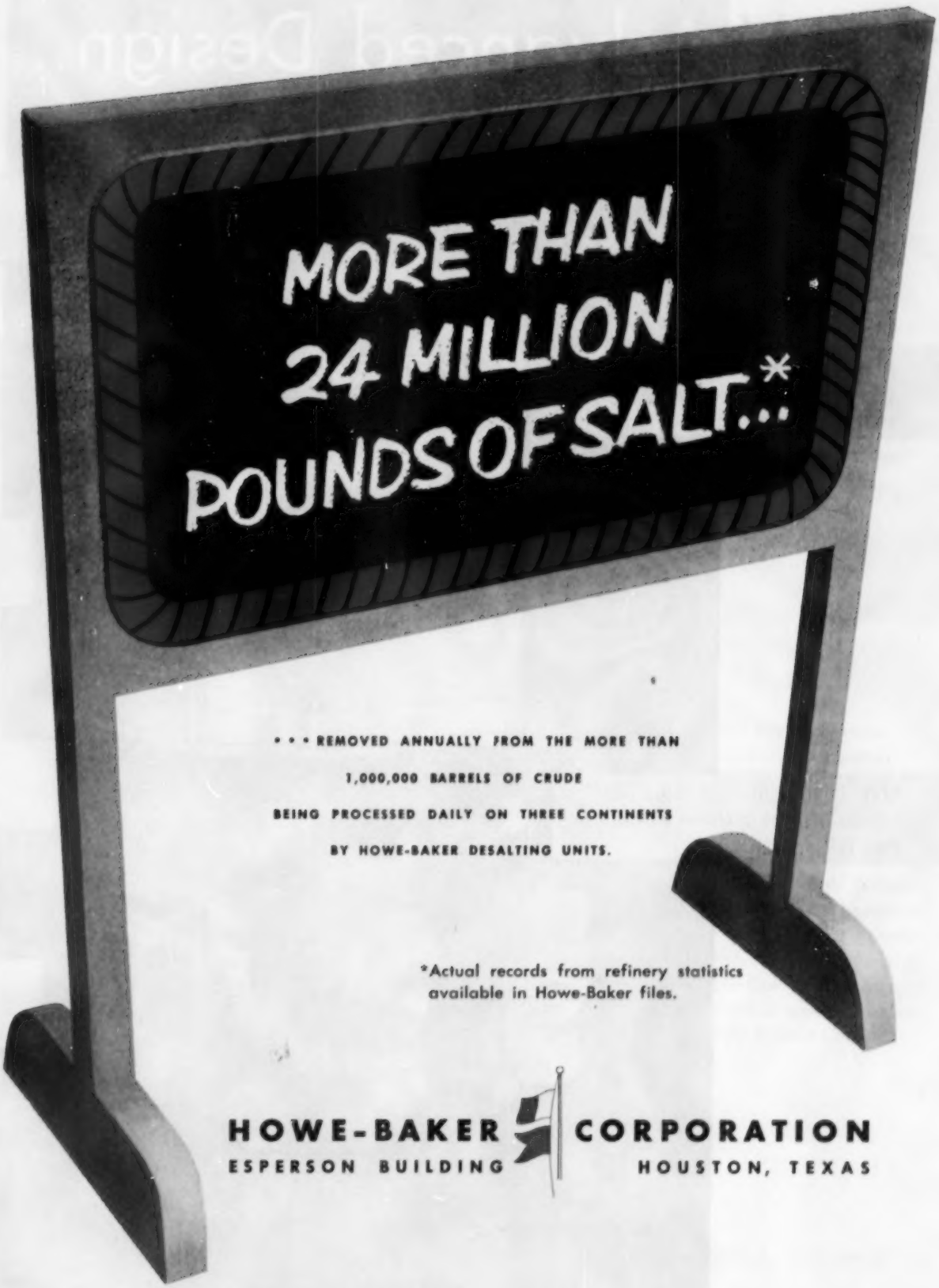
Wagner Electric Corporation
EST. 1891

WAGNER ELECTRIC CORPORATION
6458 PLYMOUTH AVE., ST. LOUIS 14, MO., U.S.A.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

ELECTRIC MOTORS
TRANSFORMERS
INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

MB3-7



• • • REMOVED ANNUALLY FROM THE MORE THAN

1,000,000 BARRELS OF CRUDE

BEING PROCESSED DAILY ON THREE CONTINENTS

BY HOWE-BAKER DESALTING UNITS.

*Actual records from refinery statistics available in Howe-Baker files.

HOWE-BAKER CORPORATION

ESPERSON BUILDING HOUSTON, TEXAS

For more data on advertised products, use Readers' Service Cards, last page.

NEW Advanced Design...

NEW HIGH SUSTAINED ACCURACY . . .
even under extreme operating and ambient conditions

NEW CONVENIENT ZERO ADJUSTMENT . . .
external—no need to remove weather-proof cover

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

d/p Cell Flow Transmitter...

NEW POSITIVE OVERRANGE PROTECTION . . . up to full 1500 lbs. cell rating

6 Major Achievements!

NEW FULLY ADJUSTABLE RANGE . . . from 0-50" to 0-250" H_2O differential

NEW AUTOMATIC INTERNAL DAMPING . . . fast, stable measurement

NEW SIMPLICITY . . . lowest cost installation

Pioneered by Foxboro 7 years ago, the d/p Cell* Transmitter established a new standard of performance in flow measurement and control. Over 40,000 are maintaining that standard in every branch of industry today. Technical advances, based on this unequalled experience, now have added even further reliability, economy and convenience. Call your Foxboro representative for a demonstration. Write for new Bulletin 13-11.

*Reg. U. S. Pat. Off.

FOXBORO
REG U S PAT OFF

first in flow measurement

THE FOXBORO COMPANY, 745 NEPONSET AVE., FOXBORO, MASS., U.S.A.

You can do it CHEAPER with UTILITY Electric Power

Low Cost. Trouble-free. Efficient Power...

That's Utility Electric Power... modern, dependable and automatically controlled ...operating, with less attention, less maintenance, and with less over-all operating costs, at refineries, petrochemical plants, on pipelines and production units, etc. Plan now to make the switch to Utility Electric Power. You'll be glad you did.

Petroleum Electric Power Association

P. O. BOX 2771, DALLAS, TEXAS

ORGANIZED IN THE INTEREST OF GREATER SERVICE TO THE PETROLEUM INDUSTRY

this
little drip
costs you money!

On a 10¢-per-gallon product, 6 CC of leakage per minute costs you about $90 per year in unnecessary product waste.

REPLACE
PUMP PACKING WITH

BJ
mechanical seals

Eliminate unnecessary stuffingbox leakage by installing a BJ Mechanical Seal. You not only realize important savings of pumped products but you also save on repacking and downtime losses. A BJ Mechanical Seal also prevents contamination of the pumped liquid ... protects against volatile and corrosive liquid hazards.

BJ MAKES
A COMPLETE LINE
OF MECHANICAL SEALS...

BJ makes reliable high-precision seals in material and construction combinations to answer almost any pressure, temperature and liquid requirements. This means that BJ can provide the *one best seal* for each specific pumping need. Ask your nearest BJ sales engineer to show you how Mechanical Seals can save you money. Or you can obtain further information by writing for BJ Bulletin No. 54-1-10,000.

BJ
SINCE 1872

Byron Jackson Co.
PUMP DIVISION
P. O. BOX 2017 TERMINAL ANNEX • LOS ANGELES 54, CALIF.
Sales Offices in Principal Cities

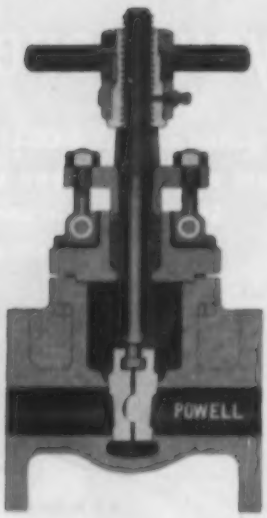
For more data on advertised products, use Readers' Service Cards, last page.

POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES

. . . THE COMPLETE QUALITY LINE . . . POWELL VALVES . . . THE COMPLETE QUALITY LINE . . .

. . . THE COMPLETE QUALITY LINE . . . POWELL VALVES . . . THE COMPLETE QUALITY LINE . . .

Preferred for Precision and Performance



Powell Valves are the choice of engineers because they know every valve is precision made, meeting every specification—every time.

And there are other good reasons why engineers prefer Powell Valves—because Powell Valves are dependable . . . economical . . . and Powell has the COMPLETE quality line of valves.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our complete line, and help solve any flow control problem you may have.

The Wm. Powell Company
Cincinnati 22, Ohio... 109th year

FIG. 2495 (Sectional)—Stainless Steel O. S. & Y. Gate Valve for 150 Pounds W. P. Double Wedge Disc is accurately guided to seat.

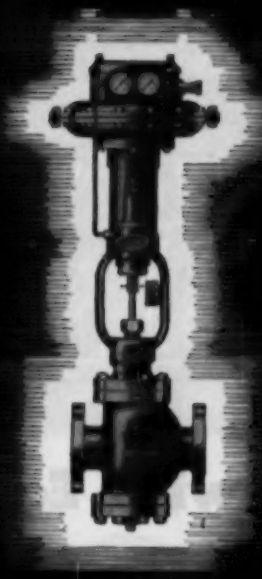
FIG. 375—Bronze Gate Valve for 200 Pounds W. S. P.

FIG. 2309—(Sectional)—Flush Bottom Tank Outlet Valve for 150 Pounds W. P. Disc Opens Into Tank.

FIG. 2193—Large Ni-Resist* Gate Valve for 200 Pounds W. O. G.

*Trade-mark of The International Nickel Co.

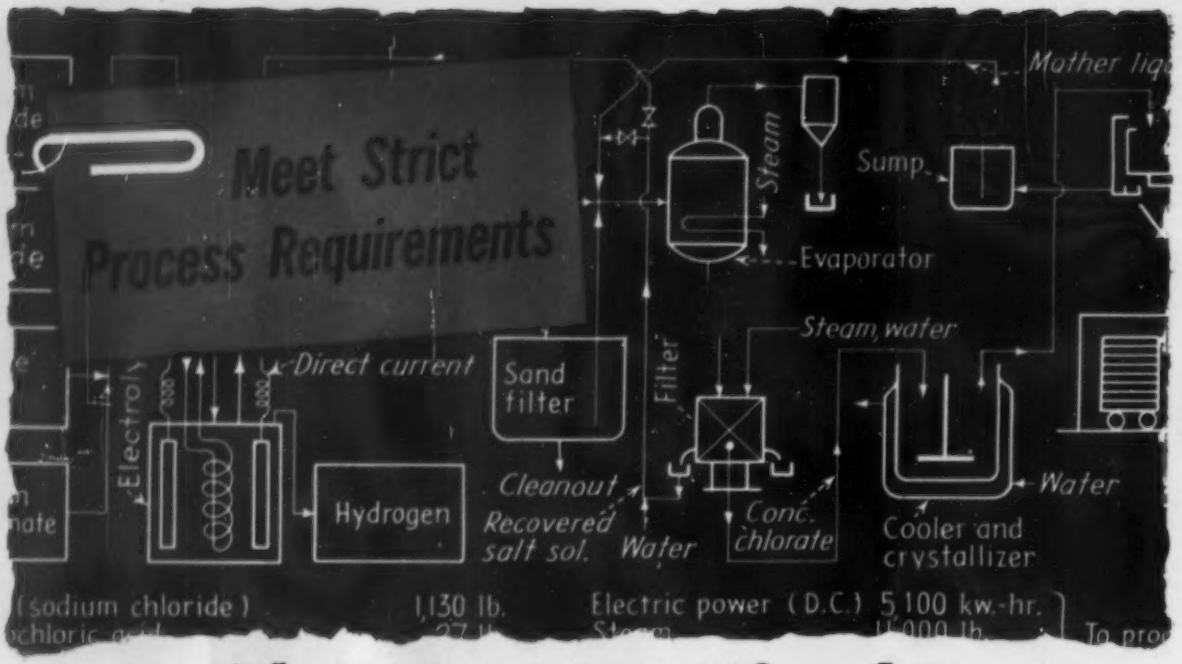
POWELL VALVES



FISHER WIZARD - - - *UNIVERSALLY ACCEPTED AS THE WORK HORSE ON SIMPLE PRESSURE CONTROL JOBS*

FISHER GOVERNOR COMPANY • Marshalltown, Iowa

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL



. . . with Eastern Centrifugal Pumps

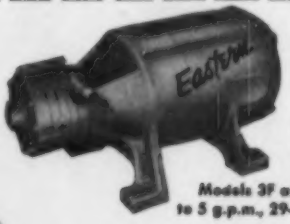
Models 2F and 2J
to 2 g.p.m., 25-42 p.s.i.

Model D-11
to 7.5 g.p.m., to 18 p.s.i.

Model F
to 17 g.p.m., to 17 p.s.i.

Models U-17 and U-34
to 38 g.p.m., to 21 p.s.i.

Models W and Z
to 70 g.p.m., to 11 p.s.i.



Models 3F and 3J
to 5 g.p.m., 29-65 p.s.i.

Recent redesign of these close-coupled Centrifugal Pumps has gained tremendous ruggedness and allowed for a wide selection of power requirements. In every detail of size, weight, space requirements, power, and costs, Eastern pumps fill the bill for strict process standards.

Six standard models range from 1/8th to 3/4 H.P., with capacities up to 70 G.P.M., pressures to 65 P.S.I. Eastern Centrifugal Pumps are available in Cast Iron, Bronze, Stainless Steel, Monel, and Hastelloy "C".

Eastern's engineering service offers many special models to meet your specific needs as to capacity and construction. Recommendations entail no obligation, and your inquiries are invited.

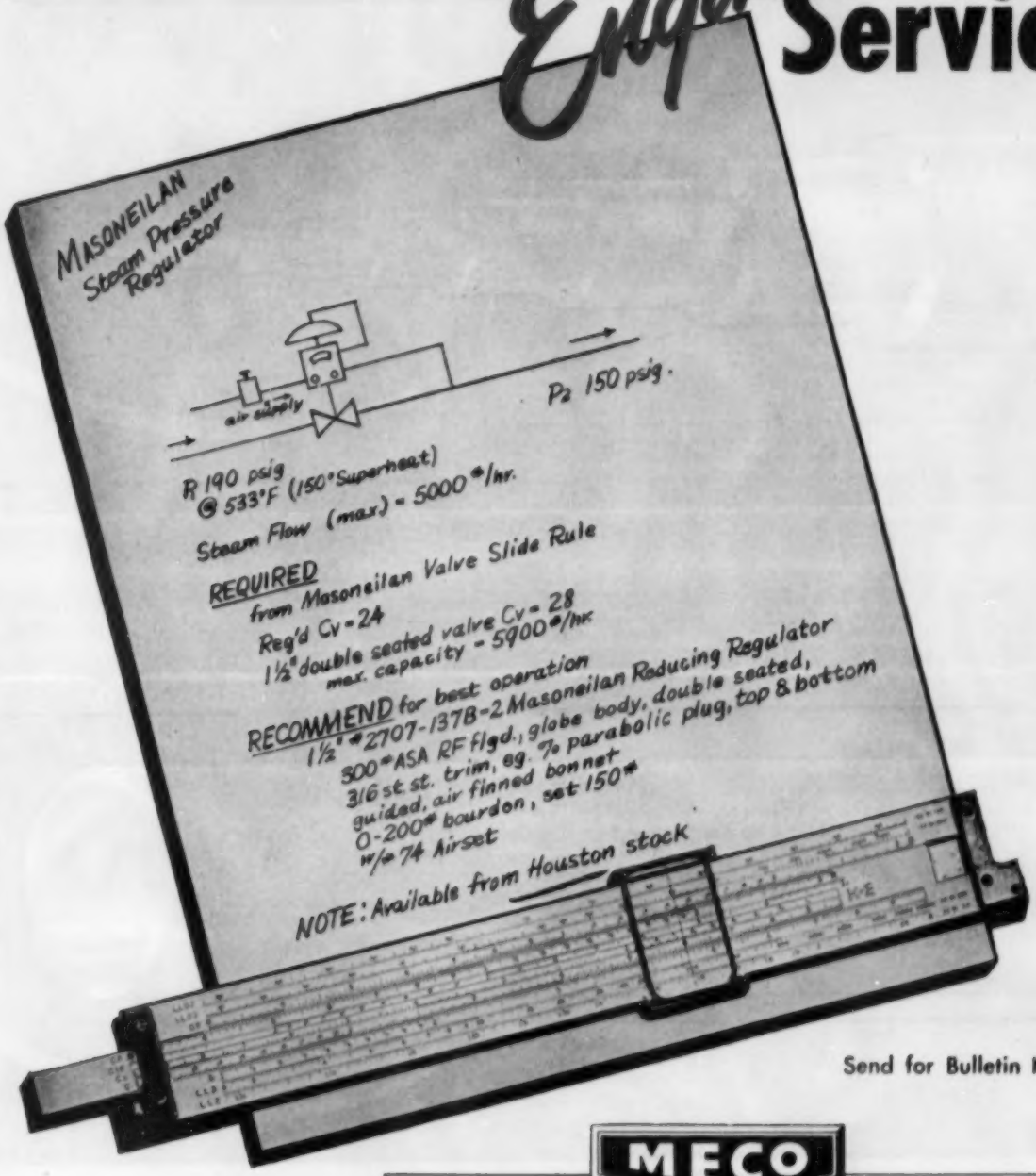
NEW EASTERN CATALOG

Eastern Centrifugal Pump Catalog contains engineering data, performance charts, diagrams and helpful general information. Request Bulletin 110G.

Eastern

INDUSTRIES, INC.
100 SKIFF ST.
HAMDEN 14, CONN.

Equipment with *Engineering* Service


MASONEILAN
Steam Pressure
Regulator
air supply
P2 150 psig.
R 190 psig
@ 533°F (150° Superheat)
Steam Flow (max) = 5000 #/hr.
REQUIRED
from Masoneilan Valve Slide Rule
Reg'd Cv = 24
1½" double seated valve Cv = 28
max. capacity = 5900 #/hr
RECOMMEND for best operation
1½" # 2707-137B-2 Masoneilan Reducing Regulator
300 # ASA RF flgd., globe body, double seated,
3/16 st. st. trim, eg. % parabolic plug, top & bottom
guided, air finned bonnet
0-200 # bourdon, set 150 #
w/o 74 Airset
NOTE: Available from Houston stock

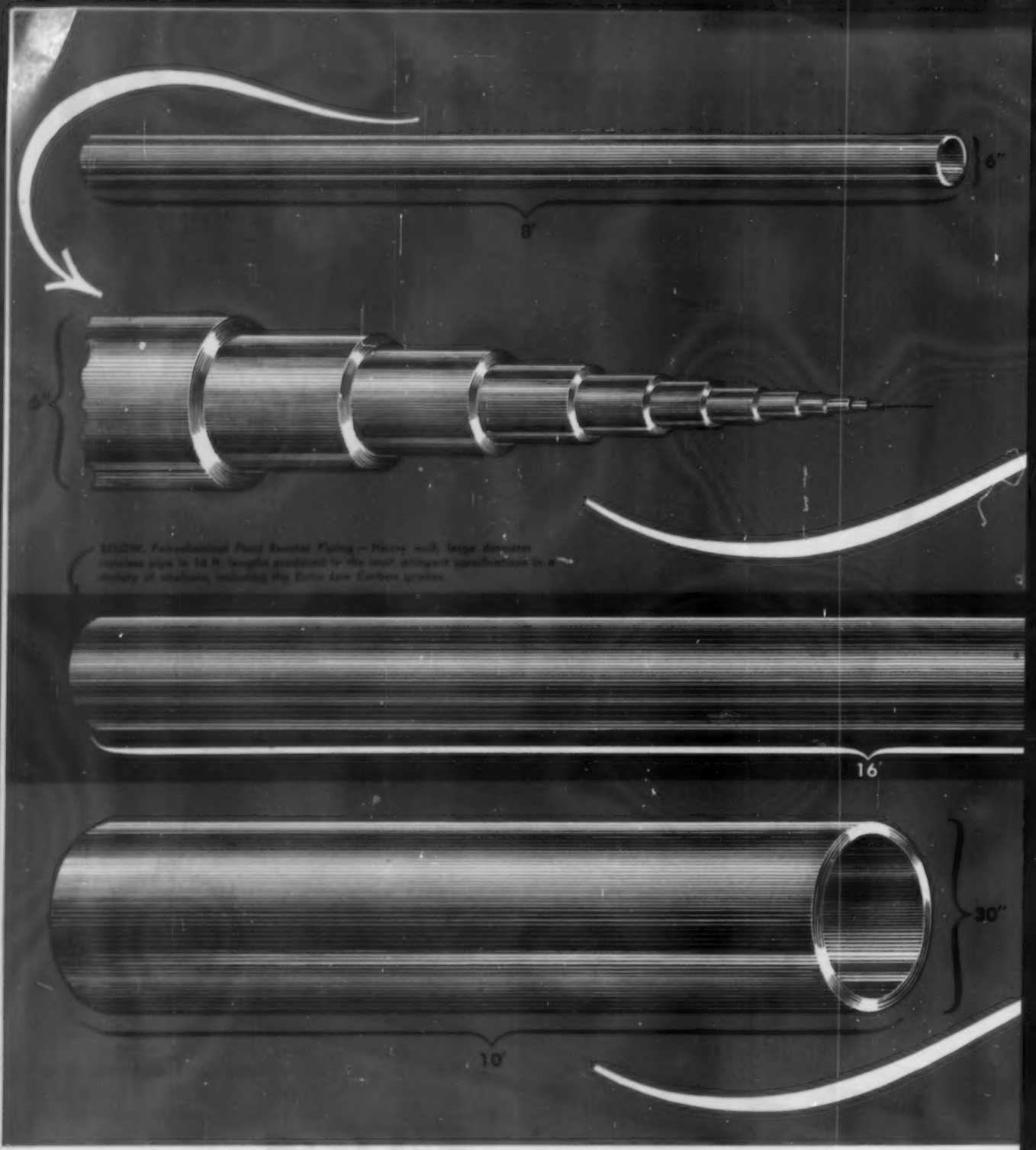
Send for Bulletin No. 405

MECO

MAINTENANCE *Engineering* CORPORATION

P. O. BOX 2687 — 3211 CLINTON DRIVE, HOUSTON, TEXAS

WRITE OR PHONE US YOUR PROBLEM



BELOW: Centrifugal Pipe Bowler Fitting — Heavy wall, large diameter concrete pipe in 16 ft. lengths produced to the most stringent specifications in a wide variety of analyses, including the Extra Low Carbon grades.

UNITED STATES PIPE & FOUNDRY CO.

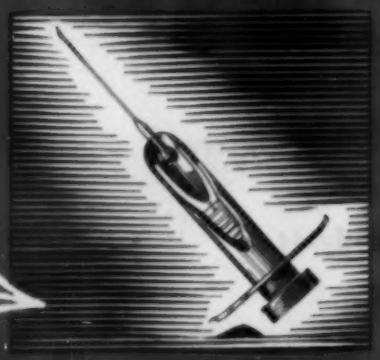
Special Products Division

SPECIAL PRODUCTS DIVISION U S P

BURLINGTON, NEW JERSEY

SALES OFFICES: LOS ANGELES, SAN FRANCISCO, CHICAGO, ST. LOUIS, CLEVELAND, DETROIT, PITTSBURGH, HARTFORD, BURLINGTON

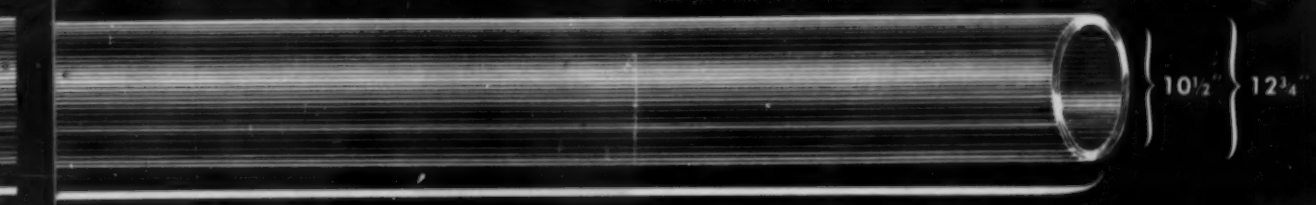
3 PROBLEMS
each different
1 SOLUTION...
stainless steel
Centrifugal Castings

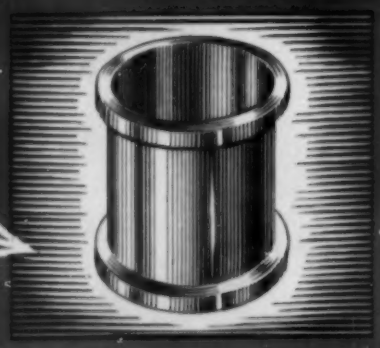


Hollow billets for cold reducing into small diameter seamless tubing, even down to hypodermic needles—ultimate proof of metal soundness! Many so-called non-pierceable grades of pipe and tubing can be hot or cold reduced from centrifugally cast billets.

Heavy Wall stainless steel pipe, centrifuge bowls, hollow billets for finely drawn hypodermic needle tubing . . .

These are among the many end uses for metal mold centrifugally cast cylindrical shapes. They are typical of the exacting, difficult service conditions to which this product is subjected. All three examples shown demonstrate the fundamental versatility of this manufacturing process—unequaled product soundness—from hypodermic needle stock subjected to the repeated stresses of cold reduction, to the centrifuge bowl spun





Centrifuge Bowl Shells produced from multiple length sections and machined to shape desired.

at 1800 RPM, to the petrochemical plant reactor piping that must pass hydrostatic pressure tests equal to 90% of the Yield Strength of the metal. These are the proving grounds of quality—of the ability to meet even the most exacting of product specifications.

We welcome your inquiries. For descriptive literature on the versatile metal mold process, write to United States Pipe and Foundry Company, Special Products Division, Burlington, N. J.

Study these advantages for your cylindrically-shaped products

- **Reduced processing time and increased production.**
- **Design of parts to suit the specific job requirements by selecting the correct alloy—not the next best available alternate.**
- **Conservation of expensive metals and alloys—especially on tubular parts now produced from solid sections.**

SIZE RANGE AND COMPOSITION FLEXIBILITY

Outside Diameter—4" to 36"

Wall Thickness—⅜" and up

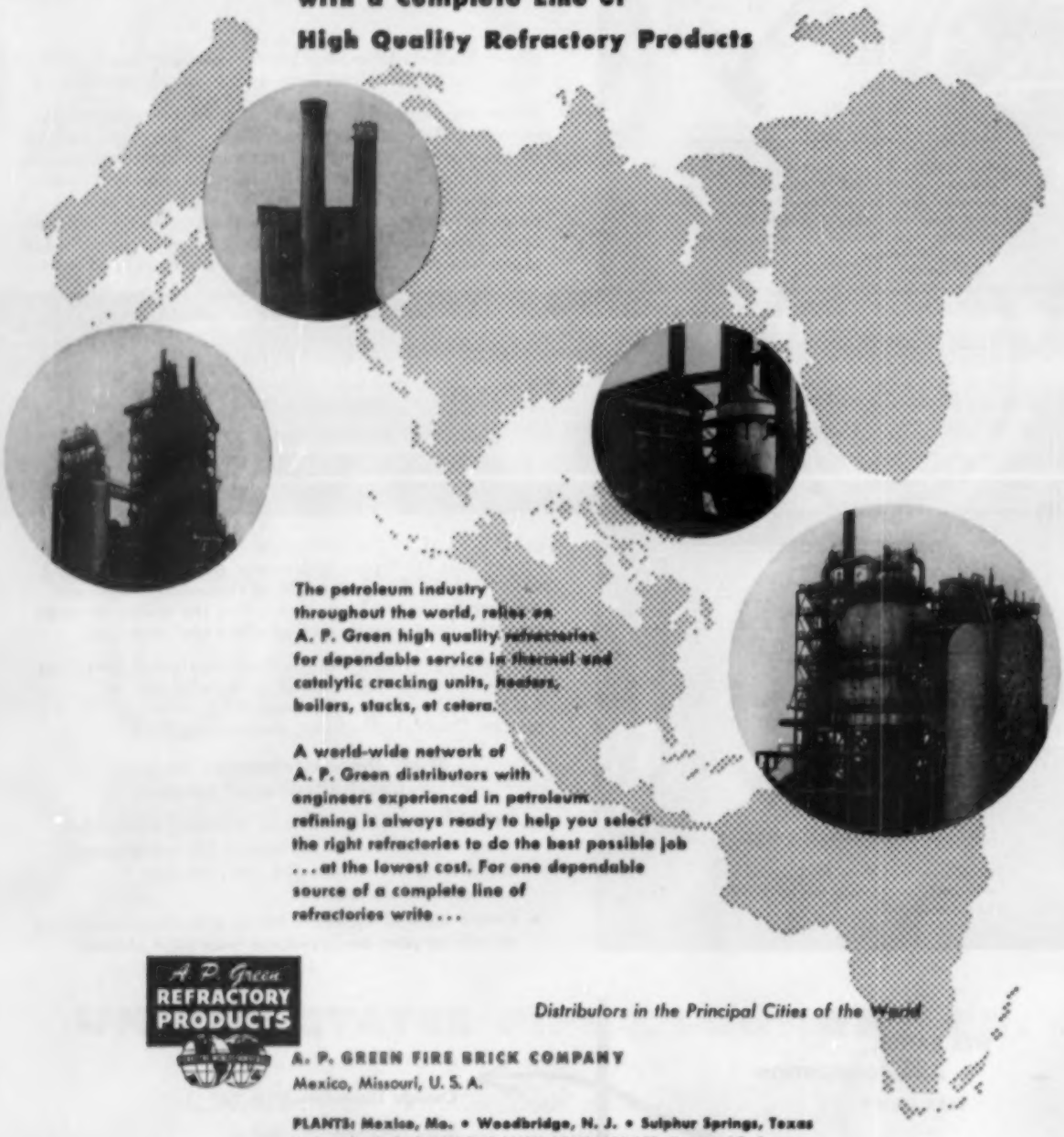
Length—Up to 16' in the "as-cast" condition

Types of Stainless Cast—All Standard AISI and ACI grades of ferritic and austenitic stainless, including No. 20 Alloy, 17-4 P H, 17-7 P H and E.L.C. grades.

throughout the world...

A. P. GREEN

Serves the Petroleum Refining Industry with a Complete Line of High Quality Refractory Products



The petroleum industry throughout the world, relies on A. P. Green high quality refractories for dependable service in thermal and catalytic cracking units, heaters, boilers, stacks, et cetera.

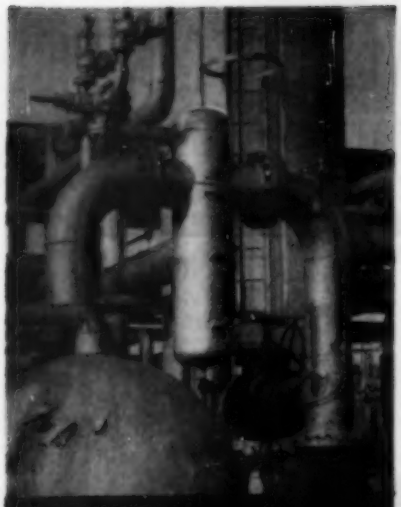
A world-wide network of A. P. Green distributors with engineers experienced in petroleum refining is always ready to help you select the right refractories to do the best possible job . . . at the lowest cost. For one dependable source of a complete line of refractories write . . .

A. P. Green REFRACTORY PRODUCTS

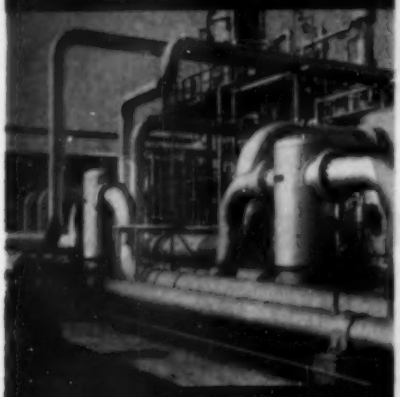
Distributors in the Principal Cities of the World

A. P. GREEN FIRE BRICK COMPANY
Mexico, Missouri, U. S. A.

PLANTS: Mexico, Mo. • Woodbridge, N. J. • Sulphur Springs, Texas
In Canada: **A. P. GREEN FIRE BRICK COMPANY, LTD. Toronto 15, Ontario**
In England: **LIPTAK FURNACE ARCHES, LTD. London, England**



A Peerless Line Separator is shown above removing entrainment from a refinery reboiler.

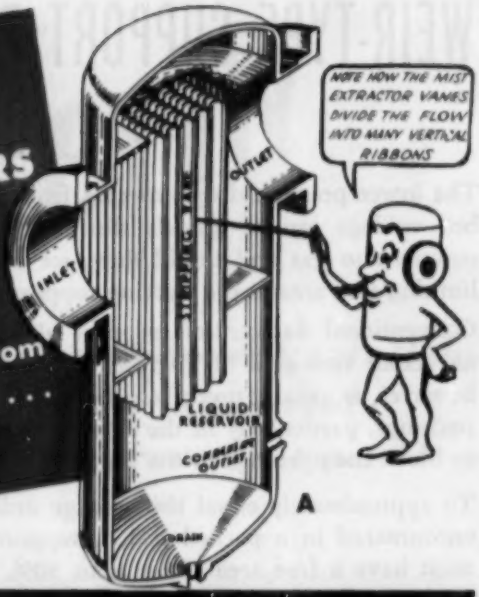


Peerless Line Separators are doing an effective job of mist extraction at this Kentucky Petrochemical Plant.

This is an insulated Peerless Steam Separator on a turbine driving an airblower.

PEERLESS LINE SEPARATORS

Outstanding for the efficient extraction of liquid mist from gas or steam . . .



HIGH EFFICIENCY—HIGH CAPACITY LOW PRESSURE DROP

Thousands of installations throughout the Refining and Chemical industry have proven the Peerless Line Separator principle to be one of the most outstanding methods available for the extraction of liquid from gas, steam or air.

Drawing A above shows the arrangement of the vanes in the Separator. Drawing B is an illustration of the Peerless principle.

The mist extractor combines the forces of impingement, centrifugal motion and surface tension to obtain its high efficiency. The path of the gas, etc., through the unit is constantly bending, causing semi-violent turbulence and rolling of the gas against the walls of the vane. Impingement and centrifugal force combine to contact the droplets with the vanes, where they coalesce, and surface tension then causes them to cling to the vanes' surfaces. Gravity and the impact of the gas stream then drives the droplets into the pockets where they roll down the vanes and out of the gas stream.

Through the Peerless method of mist extraction, the gas is stripped dry long before reaching the end of the vanes.

there's A PEERLESS SEPARATOR FOR EVERY REQUIREMENT

For any capacity
For any working pressure
For corrosive conditions
With removable vane units
With extra body length
With connections for accessory equipment
For pressure drop requirements of less than 6" water
For any vapor-liquid ratio
For any piping requirement

SPECIAL DESIGN SEPARATORS FOR ANY REQUIREMENT

FOR FURTHER INFORMATION ON THE USE OF PEERLESS LINE SEPARATORS PLEASE WRITE FOR NAME OF NEAREST PEERLESS ENGINEER.

PEERLESS MFG. CO.

PEERLESS MANUFACTURING CO.

P. O. BOX 13165 ★ DALLAS 20, TEXAS ★ Dixon 8431

REPRESENTATIVES IN ALL PRINCIPAL CITIES

WEIR-TYPE SUPPORT PLATE* IMPROVES PERFORMANCE OF ANY DUMPED TOWER PACKING

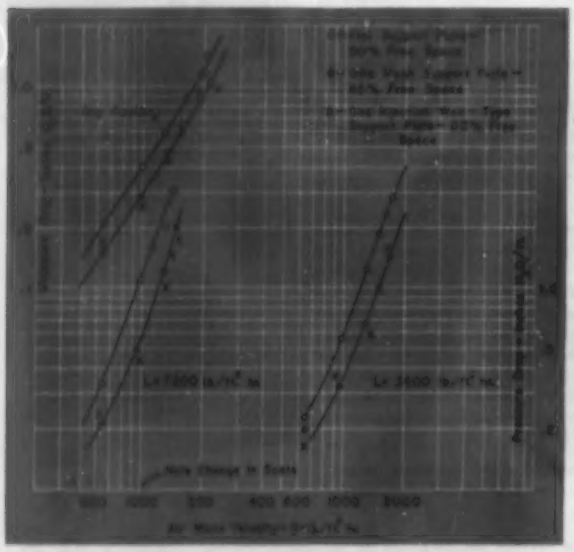
The lower pressure drop expected from a high bed voidage can be quickly dissipated by restrictions to gas and liquid flow, set up by a limiting free area in the packing support plates.

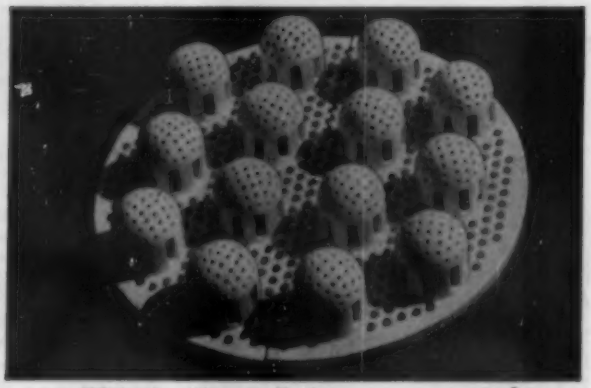
Conventional flat ceramic support plates have an actual free area of 20-30%. *Effective area,* however, is usually much less, because dumped packings, particularly in the smaller sizes, tend to block the openings in the plates.

To approximately equal the voidage ordinarily encountered in a packed bed, a support plate must have a free area better than 50%, *under actual operating conditions.*

The weir-type support plate, in every size from 12″ diameter up to 60″ diameter, has better than 50% free area. Its unique, patented design minimizes any tendency of the packing to block the plate openings. Its high mechanical strength provides ample support, and, of course, its chemical porcelain body is completely acid-and-corrosion-resistant throughout (except for hydrofluoric acid and hot caustics).

In operation, the gas is actually injected or distributed into the column through the perforated hemispherical caps and through the upper portion of the slots in the risers. A major portion of the liquid ordinarily leaves the column through the openings in the base plate, but should these openings prove insufficient, and a slight head form, the overflow will escape through the bottom half of the slots in the risers.





Write for New Bulletin — on Weir-Type Support Plates

*U. S. Stoneware patent pending

THE UNITED STATES STONEWARE CO.

Process Equipment Division **AKRON 9, OHIO**

NEW YORK **CHICAGO** **HOUSTON**

This

NEW BULLETIN

provides economical solutions to every industrial water treatment problem

ENGINEERS and consultants helped prepare this new Bulletin No. 953 . . . "Controlled Volume Pumps for Water Treating Systems."

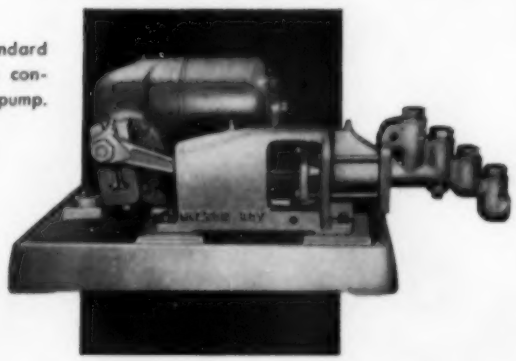
It has been termed, "a most important contribution to water treating literature."

Over fifty illustrations are used in this first-of-its-kind Bulletin, to describe and picture:

- Controlled Volume Pumps and how they work.
- Actual applications in all phases of industrial water treating.
- Basic and advanced system design.

Send for your free copy today . . . on your company letterhead, please!

For specific recommendations on water treatment problems, see your consulting specialist. For reliable, accurate flow control of water treating chemicals, see Milton Roy Company, Manufacturing Engineers, 1300 East Mermaid Lane, Philadelphia 18, Pa.



Milton Roy standard motor-driven controlled volume pump.

milton Roy
CHEMICAL FEED SYSTEMS

Engineering representatives in the United States, Canada, Mexico, Europe, Asia, South America, and Africa.

For more data on advertised products, use Readers' Service Cards, last page.

Depend on LADISH

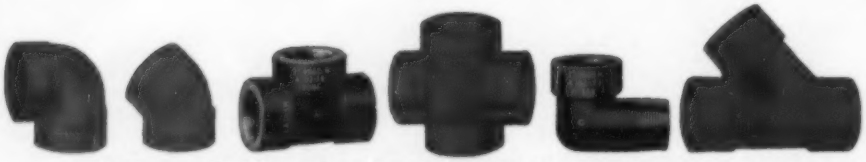
- Carbon Steels
- Carbon-Molybdenum Steels
- Chromium-Molybdenum Steels
- Nickel Steels
- Chromium-Nickel Steels
- Chromium-Silicon-Molybdenum
- Wrought Iron
- Chromium Type Stainless
- Chromium-Nickel Stainless
- Molybdenum Type Stainless
- Wrought Aluminum
- Aluminum-Copper Alloys

BUTT WELDING FITTINGS

½ inch through 42 inches . . .

FORGED CORROSION RESISTANT—LIGHT WEIGHT and A.S.A. FLANGES

½ inch through 24 inches . . .



FORGED SCREWED OR SOCKET WELDING FITTINGS and UNIONS

⅛ inch through 4 inches . . .

LARGE DIAMETER AND T.E.M.A.* STANDARD FLANGES up to 20 feet O.D.

*Tubular Exchanger Manufacturers Association

LONG WELDING NECKS up to 24 inches, 150 lb. through 2500 lb.

Complete Service . . .

BUTT WELDING FITTINGS

Schedules 5S, 10S, 40S, 80S, and other Schedules and wall thickness.

FORGED CORROSION RESISTANT—LIGHT WEIGHT and A.S.A. FLANGES

150 lb. through 2500 lb. pressure ratings.

FORGED SCREWED OR SOCKET WELDING FITTINGS and UNIONS

150 lb. Corrosion Resistant and 2000 lb. through 6000 lb. ratings.

FOR FITTINGS FROM ANY FORGEABLE MATERIAL TO MEET YOUR SERVICE REQUIREMENTS

You get prompt, efficient service when you specify and order from the complete Ladish Controlled Quality line. Fittings *in any forgeable material* in virtually every type, size, wall thickness or pressure rating . . . are produced to one uncompromising Controlled Quality standard . . . and identified with heat code symbols pioneered by Ladish as verification of metallurgical integrity resulting from exhaustive tests made in the Ladish metallurgical laboratories.

For *complete service* on your fittings requirements, depend on the Ladish line and the services of your Authorized Ladish Distributor.

THE COMPLETE *Controlled Quality* FITTINGS LINE

LADISH CO.

CUDAHY, WISCONSIN

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L

TO MARK PROGRESS

- Aluminum-Manganese Alloys
- Deoxidized Copper
- Hastelloy
- Titanium
- Forging Brass
- Everdur Bronze
- Silicon Bronze
- Manganese Bronze
- Wrought Nickel
- Nickel-Copper Alloys
- Inconel
- Monel

important advance in
year-round fire protection

NEW 3% AER-O-FOAM LIQUID MAINTAINS MOBILITY AT −20°F

For control of fires in flammable liquids, 3% foam liquids (double strength) offer obvious advantages: economy of storage space, facility in transport and handling, low cost per unit volume of foam.

The new, patented National *AER-O-FOAM Liquid, 3% Cold Foam,* combines these advantages with the ability to perform as well at sub-zero temperatures as at summer heat.

Unique in its field, this new AER-O-FOAM Liquid assures correct proportioning in the foam-making process at temperatures as low as −20°F. The extra protection is apparent.

Quick facts on performance

National AER-O-FOAM Liquid, 3% Cold Foam, is equally effective with soft, hard, or sea water.

It stores easily for longer periods because there is no deterioration under normal storage conditions.

It is compatible with almost all 3% regular liquids.

It meets all applicable requirements of U. S. Government specifications.

Special Cold-Weather AER-O-FOAM Trucks

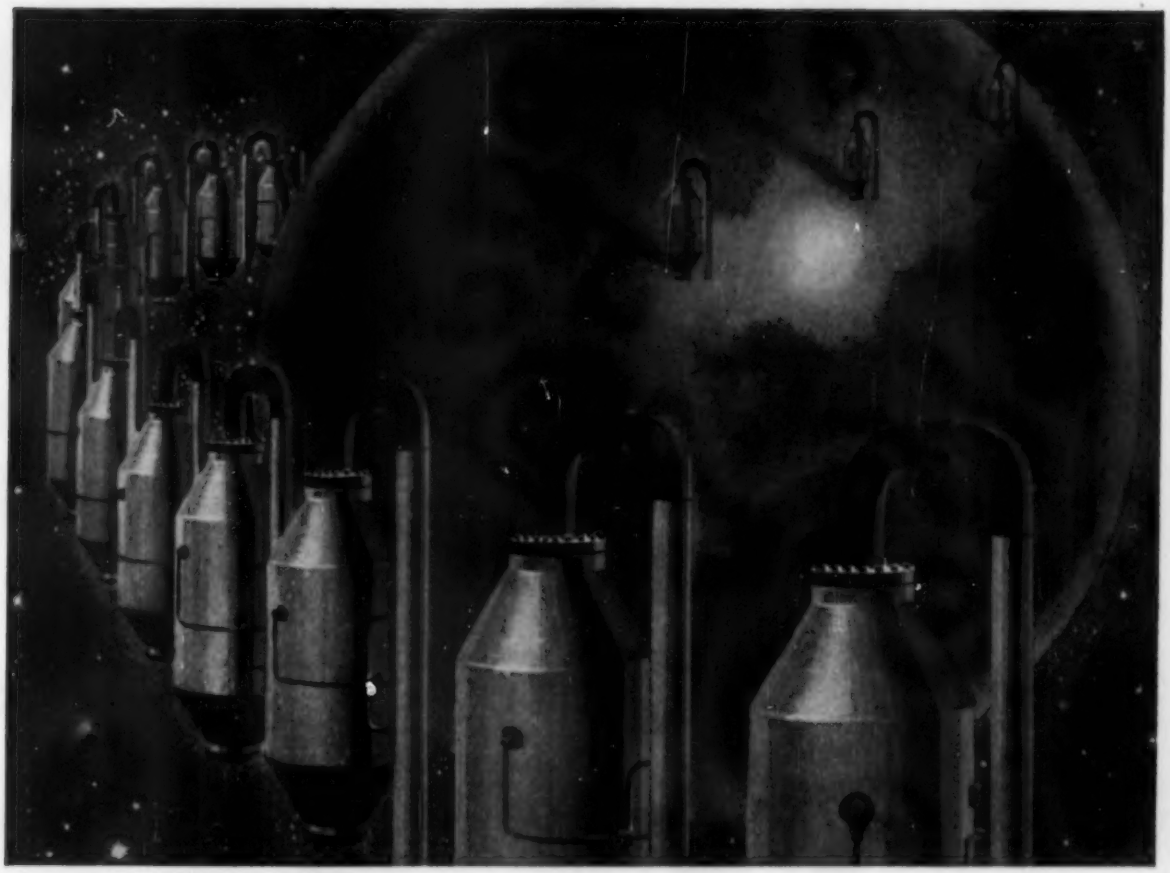
For use with 3% Cold Foam Liquid, National Foam offers special foam trucks insulated for operation in very low temperatures. Carrying up to 750 gallons of 3% Cold Foam Liquid, the trucks can produce as much as 12,000 gallons of foam per minute.

Unlimited supply

As a result of recent expansion in National Foam's production facilities, the new 3% Cold Foam Liquid is available in unlimited quantities. Full details will be forwarded promptly on request.

NATIONAL FOAM

SYSTEM, Inc.
West Chester, Pa.



Now...Thanks to Catforming...

HIGH OCTANES, HIGH YIELDS AT LOW COST!

Today, well into its third year of commercial operation, Atlantic's Catalytic Reforming Process is proving its ability to give superior results on a broad variety of feed stocks.

Catforming's simplicity brings savings through increased efficiency every step of the way—actually cutting out many intermediate steps.

Regardless of the size of your operation or the nature of your charge stock, Catforming merits your attention. One reason Catforming has "proved out" commercially is Atlantic's broad experience in all phases of petroleum refining.

Phone or write for our detailed brochure, "CATFORMING." The Atlantic Refining Company, Research and Development Dept., P. O. Box 8138, Philadelphia 1, Pa.

it's the CATALYST that counts

ATLANTIC

For more data on advertised products, use Readers' Service Cards, last page.

FORGED STEEL

ORBIT ASA CLASS FORGED STEEL VALVES GIVE TROUBLE-FREE PERFORMANCE IN THE FOLLOWING SERVICES . . . .

1. HYDROGEN
2. AMMONIA (Liquid or Gas)

3. HYDROCARBONS (Liquid or Gas)
4. BUTADIENE

WELDED BONNET CONSTRUCTION

RISING STEM

No Lubricant Required for Tight Shut-off.

This feature is important on hydrogen lines of platforming units where contamination carry-over from valve lubricants can lower catalyst efficiency.

Available in both Carbon and Stainless trim: Full Round Opening in sizes 1″ to 4″ Flanged and Screw End. Venturi Opening; Flanged only, sizes 2″ to 6″.

See 22nd Edition of Refinery Catalog or write for Catalog 55-B.

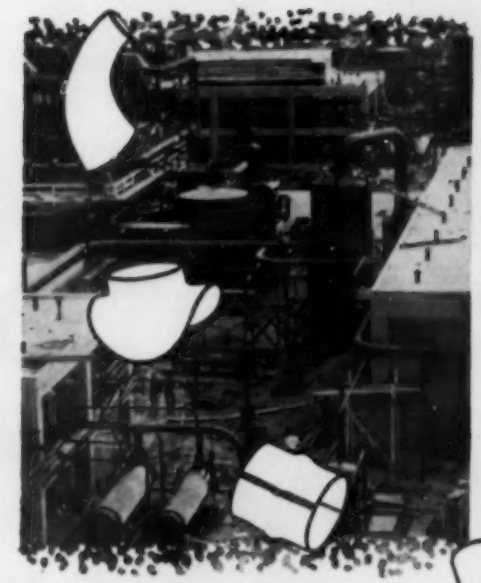
ORBIT VALVES®

ORBIT VALVE COMPANY

P. O. BOX 699 (For over 40 years) TULSA 1, OKLAHOMA

3 IMPORTANT FACTS ABOUT MIDWEST WELDING FITTINGS

Check 'em ✓



Midwest originated and developed the Long Tangent Elbow, the Reducing Elbow, Saddle, Sleeve, Shaped Nipple, and Lap Joint Stub End with large radius and heavy forged lap.

1 They are more ductile and have greater bursting strength than seamless pipe of comparable analysis.

2 They enable you to cut all pipe in exact accordance with designer's drawings. They are accurate and uniform.

3 The line is complete and varied. It gives you greater latitude in design and permits improvements and economies impossible to attain otherwise.

J&L STEEL

Jones & Laughlin STEEL CORPORATION
SUPPLY DIVISION – TULSA, OKLAHOMA
Serving The United States and Canada

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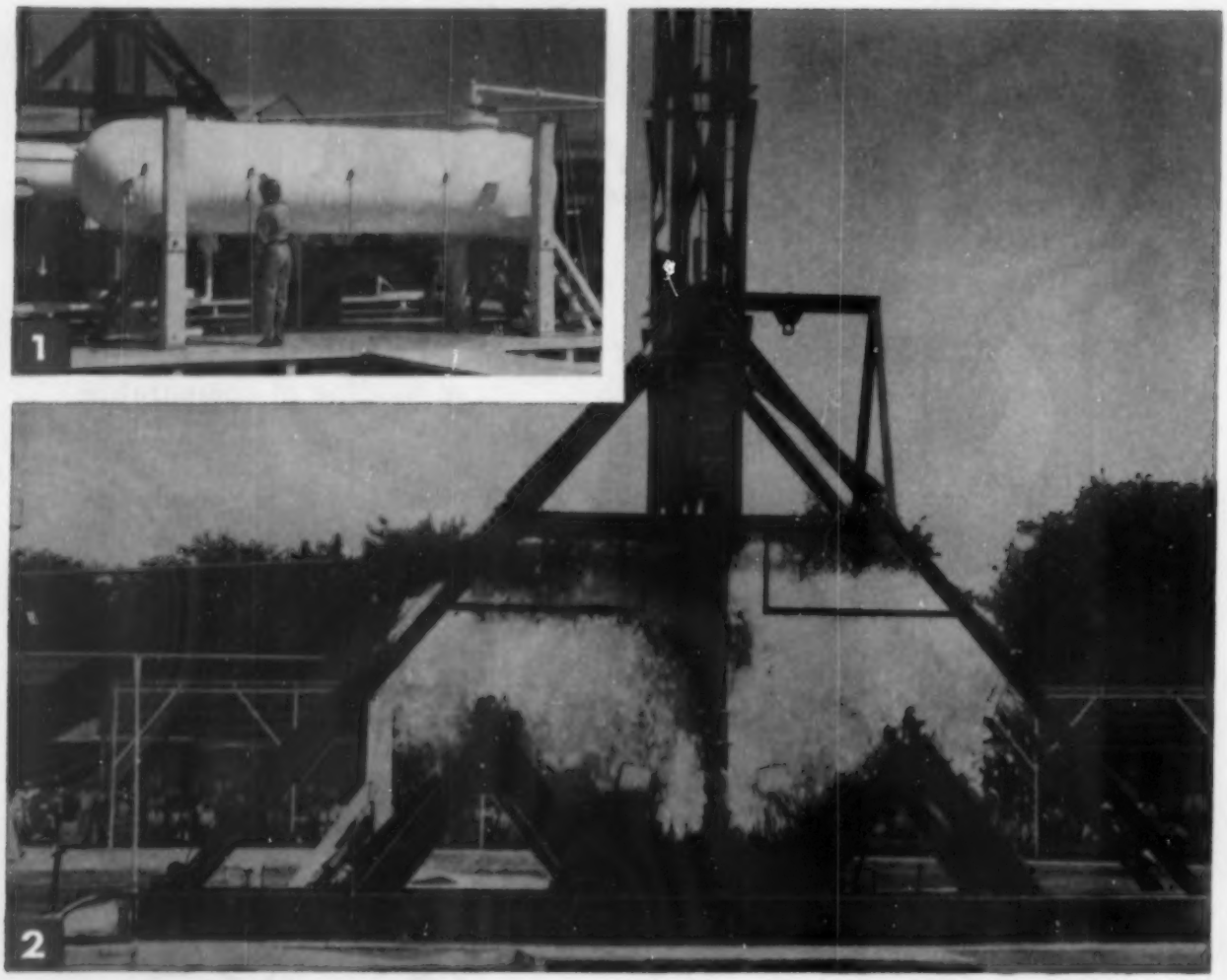
FROZEN STEEL

1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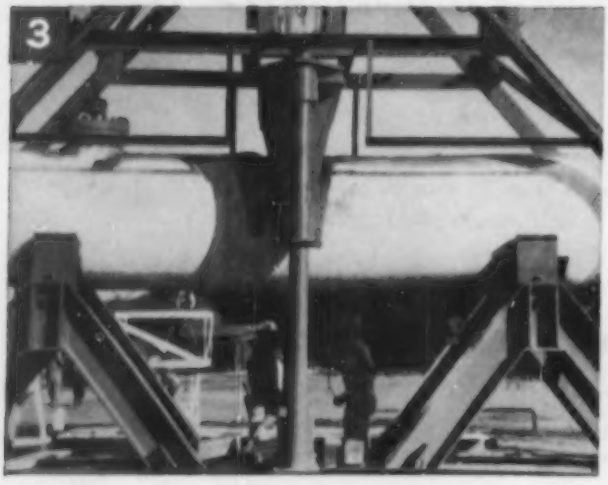
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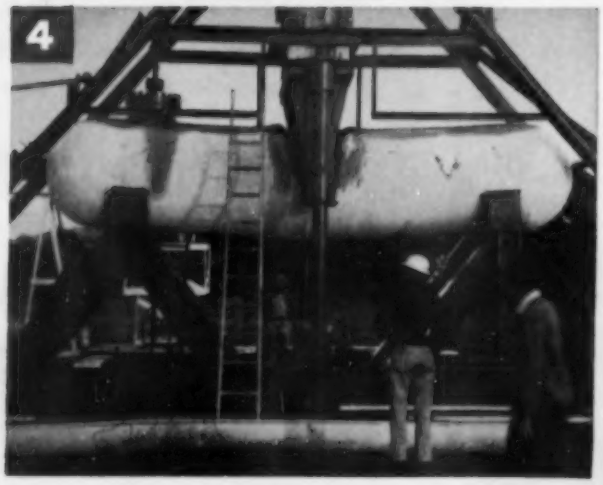

4

STAYS TOUGH!

Even at 38° below zero

new USS "T-1" Steel withstands impact of 2,000,000 ft. lbs.

YOU can count on your fingers the few materials that will withstand high impacts at sub-zero temperatures. You have an equally tough time finding more than a handful of materials that will hold up in *high* temperature, high stress applications. But new USS "T-1" Steel does *both* – that's what makes this new engineering material so very remarkable.

"T-1" Steel stays tough and durable at temperatures far below zero, yet remains strong at temperatures as high as 900° F. What's more, you get this unique combination of properties in a steel that is easy to fabricate, that can be welded or flame-cut without pre- or post-heating.

Here is proof of what USS "T-1" Steel can do. Last summer, four-welded pressure vessels made of half-inch "T-1" Steel plate were tested to destruction. Two vessels were stress relieved; two were not stress relieved after welding. Each vessel was refrigerated to temperatures far below zero, then pressurized so that the stress in the steel was 90,000 psi. (Photo #1) That stress alone is enough to rupture the average pressure vessel—it is *five times* normal design strength. But that's only the point at which *testing began* on these "T-1" Steel vessels.

A 13-ton steel ingot was raised high above the vessel . . . then dropped, repeatedly, until the vessel failed. The first drop from 52 feet knocked off the frost (Photo #2), but that's all. The steel and every weld remained intact, and the top of the vessel was barely dented. (Photo #3)

The second drop from 73 feet socked the vessel with an impact of 2,000,000 ft. lbs. at a temperature as low as –38° F. But the blow merely increased the dent another fraction of an inch. The steel held and the vessel was still sound. (Photo #4)

The third and final drop from 101 feet caused failure. With the 13-ton ingot striking at a speed of 55 miles per hour, the steel *had* to give. But it *didn't shatter* or show any sign of brittleness. It stayed tough and ductile. (Photo #5)

As a result of these tests, several major pressure vessel fabricators have requested approval from the ASME to use USS "T-1" Steel in unfired pressure vessels because . . .

HERE'S WHAT USS "T-1" STEEL CAN DO

You can use new USS "T-1" Steel to build larger pressure vessels and storage tanks . . . to use higher allowable working pressures in vessels that weigh no more than present designs.

With no pre- or post-heating required, you can fabricate vessels either in the shop or the field—whichever is more convenient and less costly. Remember, too, when you use the high strength of "T-1" Steel to reduce the thickness of welded sections, you cut welding time and the amount of welding rod needed.

Lighter weight construction with "T-1" Steel reduces shipping, handling, and material costs – and reduces the cost and weight of any foundations and supports that might be needed. Write for complete information.

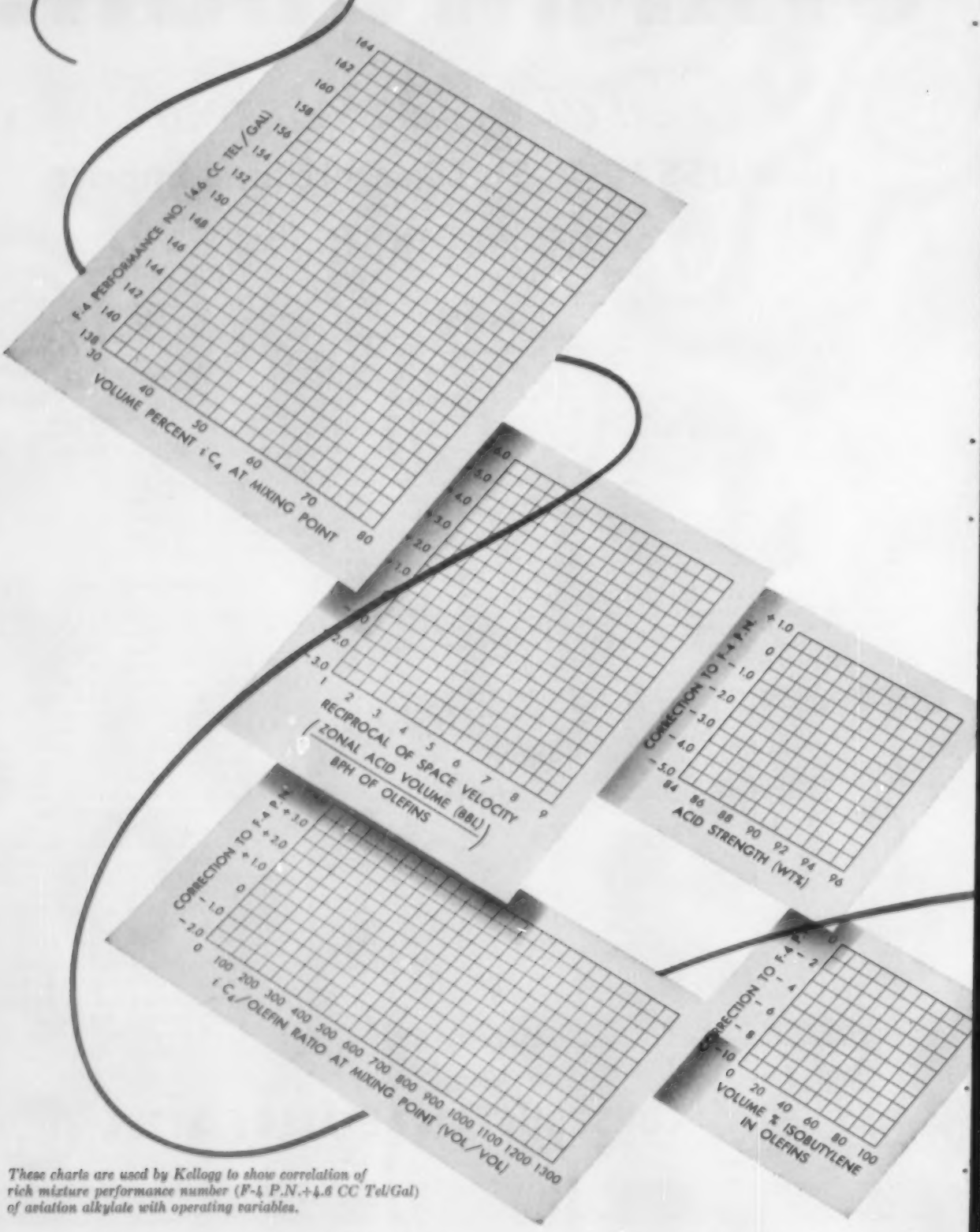
UNITED STATES STEEL CORPORATION, PITTSBURGH
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION
WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS "T1" CONSTRUCTIONAL ALLOY STEEL

USS

UNITED STATES STEEL

INSIDE TRACK IN THE OCTANE RACE...


F-4 PERFORMANCE NO. (4.6 CC TEL/GAL)
VOLUME PERCENT i C4 AT MIXING POINT
RECIPROCAL OF SPACE VELOCITY
(ZONAL ACID VOLUME (BBL)
BPH OF OLEFINS
CORRECTION TO F-4 P.N.
ACID STRENGTH (WT%)
i C4/OLEFIN RATIO AT MIXING POINT (VOL/VOL)
VOLUME % ISOBUTYLENE
IN OLEFINS

These charts are used by Kellogg to show correlation of rich mixture performance number (F-4 P.N.+4.6 CC Tel/Gal) of aviation alkylate with operating variables.

For more data on advertised products, use Readers' Service Cards, last page.

Kellogg Alkylation

-INVESTMENT PAYOUT IN ONE YEAR!

A quick way to higher octane ratings at lowest operating and investment costs is sulfuric acid alkylation—utilizing Kellogg's unique cascade reactor and auto-refrigeration system.

Providing exceptionally high yields of superior alkylate, this Kellogg process sharply reduces the cost of the isobutane recycling equipment; maintains acid consumption at the lowest possible level; assures efficient mixing in reaction sections at low horsepower.

The accompanying co-ordinates demonstrate a few of the variables confronting the alkylate process engineer. The curves of these co-ordinates have been worked out through Kellogg research and experience, and the design results are available to refiners planning new alkylate capacity.

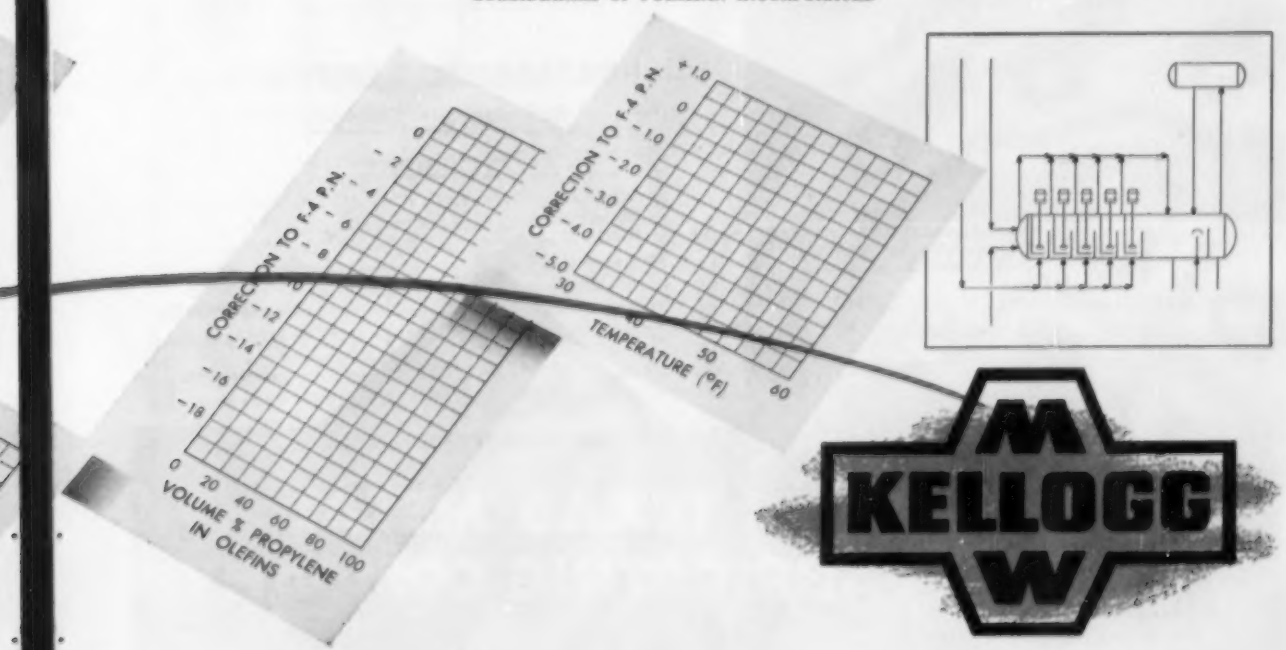
An example of what Kellogg alkylation can do in attaining premium results working with various blending components is provided by a recent study undertaken by Kellogg engineers of a proposed new 25,000 BPSD refinery on the Gulf Coast. Here, alkylation of total C_3 and C_4 olefins, assuming extraneous isobutane available at nominal price, results in the production of 15 volume percent on crude of high octane alkylate, with a payout on incremental investment over a base case of well under one year.

A comparable study of incremental alkylation not requiring extraneous isobutane, but compared with a base case incorporating non-selective catalytic polymerization, shows a payout of just over a year. Under these conditions alkylate production amounts to 6 volume percent on crude, and the combined alkylate plus catalytic polymer to slightly over 9 volume percent.

REFINERY PROCESS DIVISION, THE M. W. KELLOGG COMPANY, 225 BROADWAY, NEW YORK 7, N. Y.

In Canada: The Canadian Kellogg Company, Limited, Toronto. In Europe: Kellogg International Corporation, London

SUBSIDIARIES OF PULLMAN INCORPORATED



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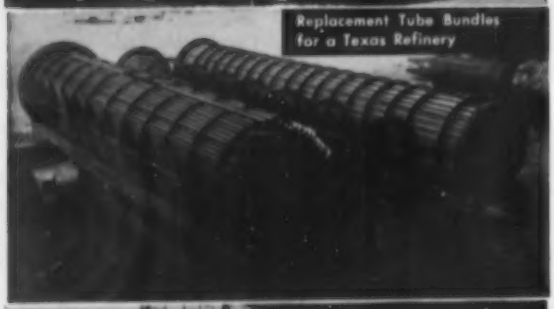
A Superior Service for HEAT EXCHANGERS

One of two identical Reboilers built for an Eastern Chemical Plant



Replacement Tube Bundles for a Texas Refinery

Texas Metal Exchangers for a Canadian Chemical Plant

The achievement of superiority in design and workmanship—unexcelled quality of construction—combined with competitive price and the lower maintenance factor of Texas Metal Exchangers is attested to by a long list of satisfied customers. It has been our privilege to serve many of the major companies in the petro-chemical industry.

We look forward to receiving inquiries and an opportunity to offer engineering counsel on any of your heat transfer problems.

Heat Exchangers • Condensers

Reboilers • Coolers

Preheaters

We cordially invite your inquiries.

API-ASME and ASME Code Construction

Qualified for Construction in Ferrous and Non-Ferrous Materials

TEXAS METAL FABRICATING COMPANY

HOUSTON

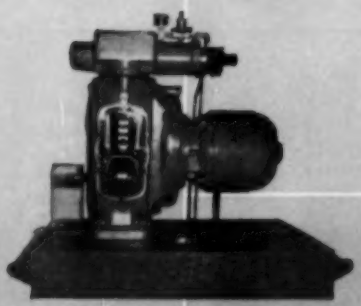
MAIL ADDRESS: P. O. BOX 7387, HOUSTON 7, TEXAS

CONOFLOW *Cylinder Conomotors*
now make possible a *complete selection* of
FINAL CONTROL ELEMENTS

Conoflow Series LB Control Valve

CONVENTIONAL—Control Valve

One of the most conventional methods of controlling practically any variable is to use a control valve to regulate the fluid stream on the discharge side of a pump or similar prime mover. This is, of course, a simple and obvious approach, but frequently poses serious problems especially when handling extremely viscous materials, abrasive materials, corrosive fluids, etc. One of the proved and accepted methods of hurdling these perplexing obstacles is to control at the source by positioning .....



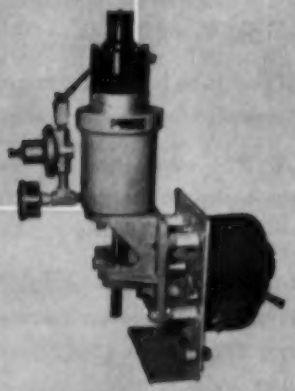
Cylinder Conomotor actuating variable speed drive (Link Belt)

.....THE PRIME MOVER—*mechanically*

In this manner the prime mover is actuated directly by the control instrument—eliminating the necessity of breaking into the line downstream to install a control valve. A most common method of accomplishing this is to control the pump speed by means of a mechanical variable speed transmission. Cylinder Conomotors are available as original equipment on a wide variety of drive units similar to the one illustrated here, including U. S. Electrical Motors, Sterling Electric Motors, Graham Transmissions, Reeves Pulley, etc. Many pumps have been adapted for direct control by using Cylinder Conomotors to automatically adjust pump stroke as in the Lapp Pulsafeeder and Milton Roy pumps. In some cases it is more practical to control at the source through electrical means by modulating .....

.....THE PRIME MOVER—*electrically*

Conoflow EB Current Controllers operating from a 3-15 or other standard range pneumatic controller are available in over 200 combinations of electrical components for controlling voltage, current, inductance, capacitance, resistance or other electrical values. A common approach to the regulation of fluid flow in this manner is to position the rheostat in the motor field or the armature circuit as a direct function of signal pressure, thereby regulating the speed of the D.C. shunt-wound motor driving the pump. On many applications, variable speed transmissions and electric motors can be controlled from zero to full capacity offering a resultant control range that cannot be matched by conventional control valves. In installations involving large capacity equipment this can prove extremely important since it eliminates the needless operation of large centrifugal pumps running at constant speed wasting power by discharging against a stalled or greatly restricted head.



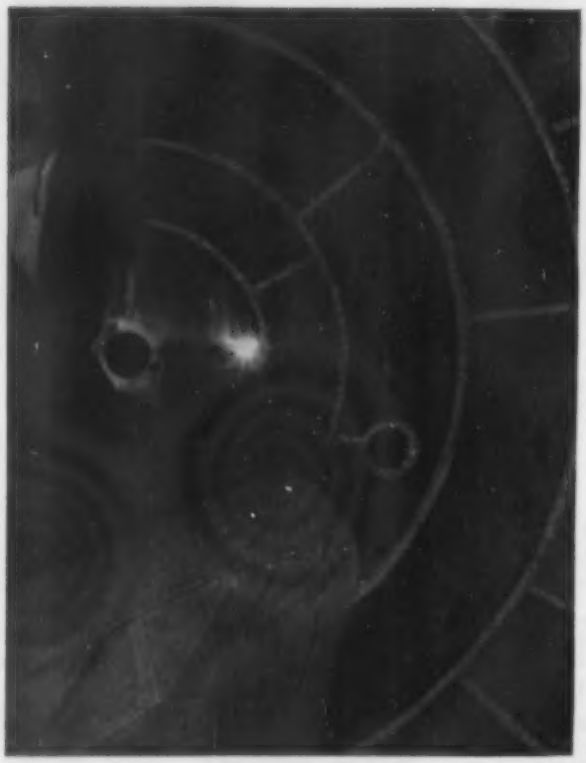
Conoflow EB Current Controller positioning rheostat

For additional information on Conoflow Cylinder Operators write for Bulletin B-50-2.

CONOFLOW CORPORATION
FOREMOST MANUFACTURERS OF FINAL CONTROL ELEMENTS
2100 ARCH STREET, PHILADELPHIA 3, PA.

For more data on advertised products, use Readers' Service Cards, last page.

How To Solve Corrosion Problems



PROBLEM: Protecting a preheater from corrosive attack during periodic contact with hydrochloric acid, trichlor benzene, and other chlorine compounds at 300 deg. F.

REMEDY: Complete lining with HASTELLOY alloy C 11-gage sheet.

RESULT: The vessel has given four years' service and is still going strong.

PROBLEM: Valving sulphur-laden flue gas at 800 deg. F. and 300 psi.

REMEDY: A ⅛-in. layer of HASTELLOY alloy B was applied to seats and seating surfaces.

RESULT: The valves gave over four years' service despite the corrosive conditions.

Free: Money-saving jobs like these are described in detail in the monthly magazine HAYNES ALLOYS DIGEST. To receive a copy regularly, write Editor, HAYNES ALLOYS DIGEST, Room 308, 30 East 42nd Street, New York 17, New York.

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Nickel-base, corrosion-resistant alloys available as sheet, plate, bar stock, welding rod, welded tubing and pipe, cast pipe and pipe fittings, sand and precision-investment castings.

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The Mail Box . . .

Octane Values Of Blending Stocks

To the Editor:

I enjoyed your article "Industry Views Motor Fuel Trend" in the April, 1955 issue of PETROLEUM REFINER. We are very interested in this subject and, as you may know, conduct a quarterly motor gasoline survey of the United States. Our April survey will be out in the near future.

Since we conduct octane blending investigations for our customers we are very interested in the octane values that are assigned to blending stocks. On Page 109 of your article you give the blending octane number of 104. Due to the fact that API Research Project 45 shows n-butane to have a blending octane number of 113 and iso-butane to have a blending octane number of 122, we are wondering about the source of your number. In the Gulf Coast Regional Laboratory we have found commercial normal butane in blends of 80 volume percent 60.0 octane number reference fuel and 20 volume percent commercial normal butane to have a blending octane value of 106 to 113.

John N. C. Cameron, Manager
Gulf Coast Regional Laboratory
E. I. du Pont de Nemours & Co., Inc.
Houston 4, Texas

The figure in question was obtained from one of the men interviewed for this article. He verifies that a blending octane for normal butane of 104 Research plus 3 cc TEL was obtained in a mixture with large quantities of catalytic reformate. He also agrees with you that the blending number can vary considerably, pointing out that at the April, 1948 "Symposium on Modern Motor Fuels" sponsored by the Division of Petroleum Chemistry of the American Chemical Society figures of 113, 102 and 109 were reported when normal butane was mixed with straight run, catalytically cracked gasoline and thermal gasoline, respectively—*Editor.*

The Editors of PETROLEUM REFINER *invite comment from readers on topics timely and pertinent to the refining branch of the oil industry.*

WATSON-STILLMAN

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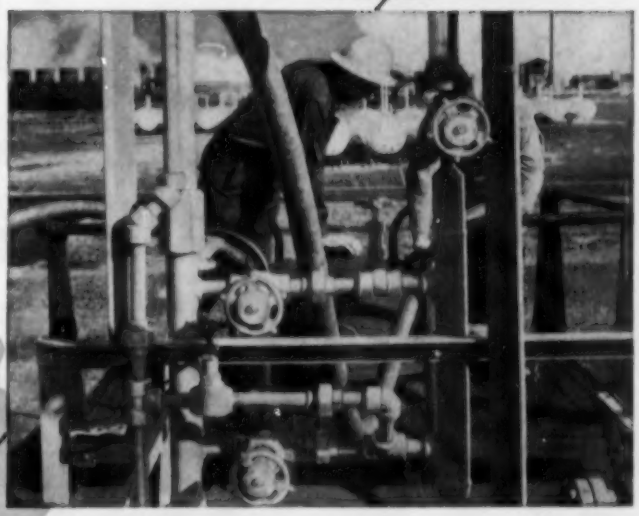

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A Quick Look at the Industry THIS MONTH

Petroleum REFINER
May, 1955

Industry decentralization is no defense against powerful new bombs. Civilian defense experts who have been demanding that government force industry to scatter plants, thereby reducing size of targets, are being shushed by pronouncement that "dispersal can't be looked on as an end in itself." New bombs, new dangers from fall-outs make dispersal futile, says Defense Mobilization Director Arthur Flemming. Furthermore, dispersal on scale needed to do any good at all would be disruptive to economy.

-•-

Better reason for decentralization is growth of automation. As American Development Industrial Council was told last month by Dr. Cledo Brunetti of General Mills, new automatic machines are producing more goods faster, making them less dependent on large labor pools to be found near cities. Future emphasis on plant locations will be placed on proximity to raw materials or to markets. Other results of automation:

One-story buildings will be rule, because automation demands horizontal production lines.

There will be fewer production workers, but they will be of higher skill. Engineers, designers, installation and maintenance men will replace assembly line employes.

Automation will also mean greatly increased maintenance expenditures, in opinion of Howard F. McCullough of General Electric. U. S. industries must double housekeeping outlay to about $22 billion annually in next ten years, he told Electrical Maintenance Engineers Association of Southern California.

-•-

You have almost doubled your salary in last five years—if you are typical of engineers who graduated in 1949. Dr. Frank S. Endicott of Northwestern University surveyed 71 companies, found that average monthly salary of fresh-from-college engineers in 1949 was $270. Average annual raises of almost $50 per month have now boosted average monthly earnings to $513.

Engineers have best potential to advance into management ranks, survey showed. Of 97 polled on this, 48 picked engineers, 28 selected commerce graduates, and 21 chose liberal arts men.

-•-

Chemical industry mergers are getting tough looks from Democrats and Republicans alike. Federal government was given power to take merging companies into court under provisions of still-untested 1950 amendment to Clayton Act. Both parties are now ready to use that power. Administration is preparing additional anti-merger cases. Dem-dominated Congressional committees have demanded and received investigation funds. Result will be probe upon probe, noisy if innocuous, with chemicals an early target.

-•-

Economical recovery of permanent anti-freeze from spent solutions is now possible. Solution is treated with caustic, then distilled. Lye or caustic removes the acidic materials which corrode engines and radiators. Upshot is, motorists may be able to trade in spent glycol anti-freeze and receive credit toward fresh charge each year.

-•-

Soviet petroleum exports will decline as result of new policies of Kremlin rulers. Reversal of rising export trend is in line with new emphasis for rapid buildup of heavy industry within USSR and Communist satellite nations. Former Premier

A Quick Look at the Industry (continued)

Malenkov attempted to disrupt petroleum market stability in Western world by increasing oil exports.

Reversals of this policy is already apparent and decline in exports will continue.

-•-

Acrolein and hydrogen peroxide will be intermediates made in new Shell Chemical glycerine plant at Norco, La. This will be one of first high-volume uses for acrolein—a highly reactive member of aldehyde family. New process probably involves acrolein production by catalytic oxidation of propylene. Availability may be stimulus for increased usage of this interesting material.

-•-

Improved techniques have shrunk cost of producing crude oil from shale by 25 percent in four years. Interior Department's annual report says cost is now $2 per barrel. Maximum size northwestern Colorado industry might reach would be between 1 million and 2 million barrels of crude shale oil daily, declares Interior. One limiting factor would be availability of water.

Meanwhile, there is aggressive development. Union Oil of California, with stake of 50,000 acres in shale and many years of research on retorting process, has selected an engineering contractor to build demonstration plant in Garfield County. Using different approach, Sinclair has announced controlled underground combustion method. Process is undergoing tests to develop techniques and cost data. Sinclair has reserves equal to 700 million barrels of oil.

-•-

Don't expect immediate relief in natural gasoline prices. Natural's place in octane picture is dimming. Refiner is plagued with same problem—what to do with straight run naphtha in natural gasoline boiling range.

-•-

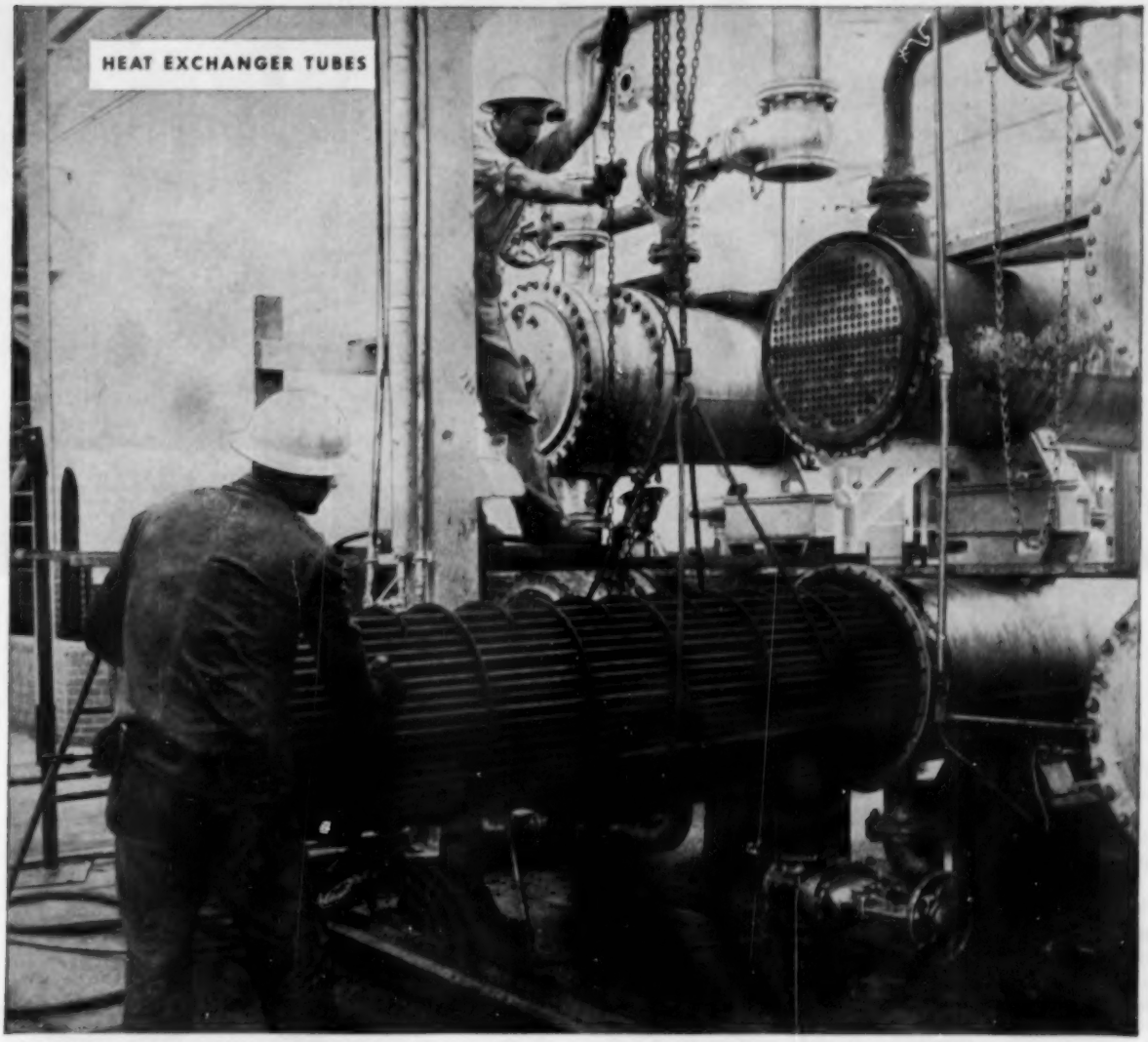
Ziegler Process for polyethylene manufacture is causing stir among companies with high-pressure facilities in operation or under construction. Rumbles of this process have been coming out of Germany for some time. While not tested on a commercial scale, low-pressure process appears to have reached licensing stage. It will receive close scrutiny.

-•-

AFL-CIO merger may be completed by Thanksgiving. Shortly afterwards there will be new flurry of organizing activity aimed at (1) recruiting new members, and (2) reviving interest in areas where unionism has lagged. Sure tipoff on post-merger plans came when Walter Reuther's CIO auto workers endorsed his proposal to contribute $1.5 million to finance organizing drive. Lesser unions will follow pattern, including oil and chemicals group, which has already been mapping campaign to (1) raise chemical workers' pay to level comparable with oil members; (2) merge with AFL chemical workers by next year; and (3) bring independent unions under CIO banner.

Most difficult task will be absorption of independents, who stand to gain little in return for surrendering autonomy. Timely reminder of their present well-being is API study for 1946-53 period. During those years average weekly earnings of refinery workers rose 65 percent to $94.19, production workers 70 percent to $90.39. National manufacturing industry average is $71.69. In terms of purchasing power, average refining-production earnings have risen 20 percent since 1946.

Plans for merger of independents in Jersey Standard group are further obstacle to CIO ambitions. Committees from three of 13 independent unions in Jersey family have already agreed on consolidation. Esso International Union may come into being about September 1 at convention in Baltimore.



PERFORMANCE RECORD of these tubes under actual operating conditions is now a part of Anaconda's extensive collection of case histories.

Use of Anaconda Cupro Nickel, 10%-755 Tubes in Texas refinery may answer your tube problem

Imagine a collection of tube performance case histories that can answer many of the corrosion problems you face!

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Here's a case history we are now adding—the use of ANACONDA Cupro Nickel, 10%-755* Tubes in the Port Neches Refinery of a major oil producer.

These tubes—in use two years—cool heavy gas oil in an Alco Exchanger on a Crude Pipe Still Unit. Gas oil at about 500°F.—mildly corrosive—comes in contact with the outside of these tubes. Brackish river water—with a high salt content—circulates through the tubes. Yet the tubes show no sign of corrosion.

CUPRO NICKEL, 10%-755 resists corrosion almost as well as Cupro Nickel, 30%-702; yet it costs much less. Polluted sea water and sea water with entrained air—even at relatively high velocity—have little effect on this alloy.

Help for your tube problem. No one tube alloy serves best under all conditions. Your problem is one of choosing the right alloy for the job. Let Anaconda's Technical Department help you. Write, outlining your operating conditions, to Dept. TD, *The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.*

*U. S. Patent No. 2,074,604

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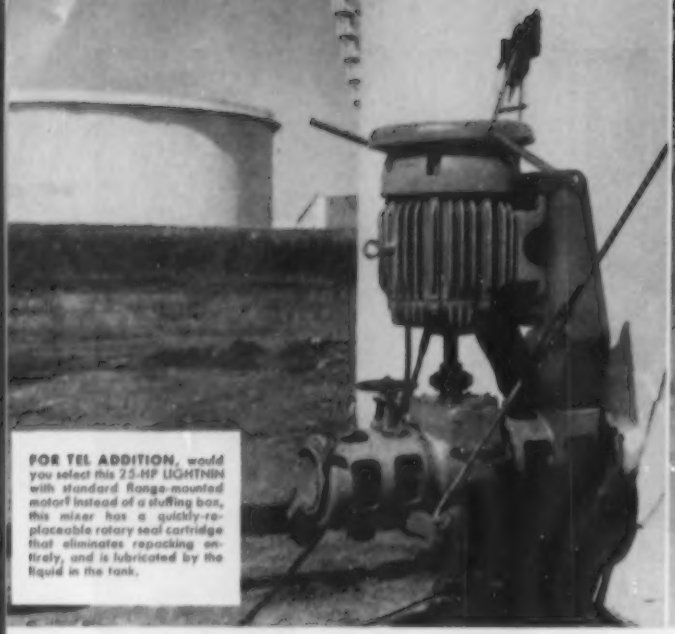
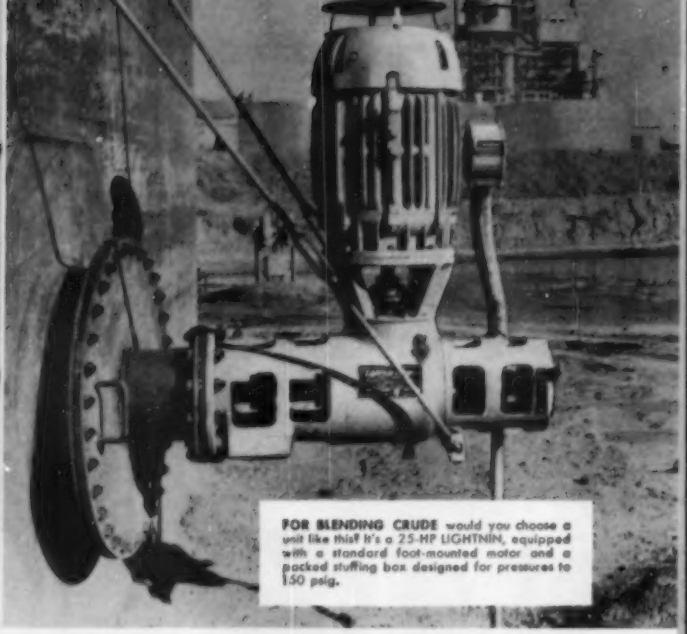


FOR TEL ADDITION, *would you select this 25-HP LIGHTNIN with standard flange-mounted motor? Instead of a stuffing box, this mixer has a quickly-replaceable rotary seal cartridge that eliminates repacking entirely, and is lubricated by the liquid in the tank.*



FOR BLENDING CRUDE *would you choose a unit like this? It's a 25-HP LIGHTNIN, equipped with a standard foot-mounted motor and a packed stuffing box designed for pressures to 150 psig.*

How to match any given set *of mixing or blending conditions*

Which mixer would *you* specify for a big blending job?

These pictures show just *two* ways you can buy LIGHTNIN Mixers to suit a specific mixing or blending operation.

There are many, many more ways to do this. For example:

MOTORS. You can order LIGHTNINs with the motor that gives you best service and minimizes your stock requirements: any make with NEMA frame; any current characteristics; any enclosure or insulation.

DRIVES. You can choose a highly efficient gear drive, or a lower-cost V-belt drive, for power input to the mixer. On gear drive LIGHTNINs, you can have a fluid coupling between motor and drive to handle excessively high starting torques.

SHAFT SEALING. You can specify the new rotary seal mentioned above (it's saving many oil companies several thousand dollars a year on maintenance). Or you can have your pick of *four* standard packed stuffing boxes, two of which permit repacking without draining the tank.

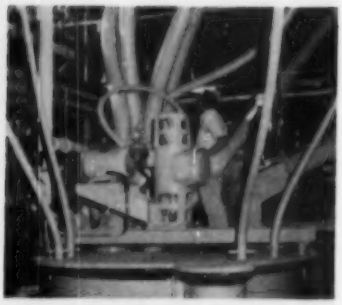
SIZES. You have a full range of sizes to choose from—18 basic models, 1 to 25 HP—so you get a mixer closely fitted to your needs.

MATERIALS. And you can write your own ticket on corrosion-resistant materials for shafts and propellers. You can get these wetted parts in *any* machinable metal or alloy—and with special covering if you want it.

You don't pay more for this freedom of choice. You *save*—because you cut your mixer operating, maintenance, and parts-stocking cost for *as long as the next 20 years.*

That's why it pays to look for the mixer that gives you *most choice* for the money.

Your LIGHTNIN Mixer representative will help you find it—quickly, without obligation. His name is in your copy of Refinery Catalog. Why not call him today?



GET THE ONE correct flow pattern that can give optimum fluid mixing results—with turbine-type LIGHTNINs for open or closed tanks. Hundreds of power-speed combinations are available, in sizes from 1 to 500 HP. Results guaranteed.

OPEN TANK becomes an efficient mixing vessel when you add a LIGHTNIN Mixer. Propeller unit, one of 30 models ranging from ½ to 3 HP, tumbles and rotates the batch rapidly to achieve uniformity in least possible time.

Get these helpful facts on mixing: *cost-cutting ideas on mixer selection; best type of vessel; installation and operating hints; full description of LIGHTNIN Mixers. Free—no obligation. Just check data you want, tear out and mail to us today with your name and company address.*

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- ☐ B-104 Side Entering Mixers
- ☐ B-107 Mixing Data Sheet
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What's Needed in Research?

V. A. Kalichevsky,
Consulting Chemical Engineer

RESEARCH is not a mystery although some may think that it is an unfailing cure for any difficulty encountered in business and an easy road to success. To them it appears that research and salvation are synonyms and that research can extricate anybody from a most desperate situation irrespective of the time factor involved. This illusion disappears with the realities of life: research is a diligent investigation, a systematic study of phenomena by the experimental method. Special personnel is required to handle it.

Statistically, research might be divided into two main branches: abstract research and applied research. Abstract or fundamental research has, as its objective, discovery of the laws of nature irrespective of their practical value. The success of free enterprise depends on its ability to make profit, and fundamental research offers little inducement for a short term investment. Applied research presents better possibilities in this respect and is, therefore, of greater commercial interest.

Applied research has two statistical subdivisions: industrial research and technical service. Industrial research selects the promising ideas from the fundamental research and develops their commercial potentialities. Technical service is engaged in improving the operation of existing equipment and products.

Success in research depends on the achievements of an individual. An inquiring mind cannot be regimented and so restrain its thinking to a narrow field with artificially imposed limits upon mental activities. Such a mind will either change the restrictive surroundings or become uninterested in the work. This has a direct and an unfavorable effect on the productivity of a research organization. From the business point of view, it does not matter how and where ideas originate provided they are profitable. For this reason, the statistical basis for the division of research is bound to be violated by the individual even if he makes a sincere effort not to transgress the assigned line of thought.

Research is an inquiry into the unknown. A person engaged in research must visualize the position of the continually shifting boundary between the known and the unknown in order to be efficient in his work. The position of the boundary depends on his background and ability in following up the new discoveries. Few persons are willing to spend most of their lives in search for the unknown. Still fewer retain their imagination after such studies, which might leave one with the impression that everything worthwhile has been already discovered. This was the conclusion of the head of the British Patent Office a century ago when he suggested that his department be closed.

Like all other fields of human endeavor research needs guidance, man-power and tools. The choice of personnel and equipment varies with the activity. Assuming that research may be divided into three artificial branches, certain generalizations can be made for their respective activities.

Fundamental research is in the realm of science, and the person engaged in it must have a thorough scientific background for this pursuit. This type of research requires much individual attention and may necessitate the development and use of highly specialized equipment. For this reason guidance and manual work are often done by the same person. The instruments employed are very precise, and the quantities of materials handled are usually small.

Industrial research presumes knowledge of both science and practice. Otherwise, a person cannot interpret scientific discoveries into commercial achievements or pass a competent judgment on the problems to be studied. The equipment employed is often well standardized; this offers opportunities for mass production of experimental data and the limited use of both highly specialized and comparatively unskilled labor. The degree of precision required for this type of work depends on the economics of the processes under development and is normally less than that needed in the fundamental research.

Technical service demands knowledge of science and commercial practice, and familiarity with the equipment operated by a particular plant. The scientific background is needed for several reasons: information that might be passed along these lines by the industrial research may be inadequate for plant purposes because of differences in interests; scientific studies relating to the well-established processes may never be uncovered by industrial research; the results of the work done by the technical service and through plant experience may offer a fertile field for scientific generalizations of direct practical value and form a basis for the development of new processes or the improvement of existing ones. A thorough acquaintance with commercial practice is also needed for many reasons. Technical service is responsible for operating economy; this demands an intimate knowledge of the best methods for achieving it as practiced by the industry at large. It must know whether a certain operation is or can be protected by patents; it must foresee possible changes in the types

Du Pont's new polymeric additives help prevent engine sludge under low-duty driving conditions

Which

of these two new lube oil additives will do most to help sell your motor oil?

If you are looking for an outstanding sales theme to help expand your motor oil market, here are two entirely *new type* Du Pont lube oil additives that offer just such an opportunity.

Both are *polymeric* additives that provide an economical and effective means of preventing engine oil sludge . . . particularly under low-temperature, low-power, stop-and-go driving conditions. Both do double duty as detergents and V. I. improvers.

As such, they can add important sales appeal to your products in the mass passenger car field as well as in bakery and other urban fleet markets.

With either of them, in multigrade oil formulations, you supply not only superior low-duty detergency, but also *provide a substantial part* of the viscosity index improvement required.

Usually such formulations produce better performing oils at lower cost than can be obtained through other additives or methods.

DU PONT LUBE OIL ADDITIVE 564 is a new type polymeric additive which, because of its relatively low molecular weight, provides your oil with excellent shear stability in engine operation.

DU PONT LUBE OIL ADDITIVE 565 has a higher molecular weight than Lube Oil Additive 564 for greater viscosity index improvement.

Form no sludge

These ashless polymeric lube oil additives permit more efficient operation of the engine oil system. Oil screens, rings, pistons, filters and other engine parts are kept clean and free from sludge. The resulting free flow of oil throughout the entire engine system keeps it in better operating condition for longer periods of time.

Commercial quantities of both additives are now available. For testing their effectiveness in your own motor oils, any of our representatives or regional offices will be glad to supply you with samples.

TO HELP YOU MERCHANDISE your lube oils containing Du Pont Lube Oil Additive 564 or 565, this unique promotion kit is now available. It contains *suggested* copy and layout for newspaper ads, descriptive folders, a 24-sheet highway poster, an envelope stuffer, and suggested sales talks for your dealer meetings. Also, a 12-page technical book with all the basic details on these new additives.

In addition, representatives of the Du Pont Petroleum Chemicals Division will be glad to work with you in designing a special lube oil promotion plan capitalizing on the advantages of these additives. Be sure to ask about this important Du Pont marketing service.

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of material produced and their desirable characteristics in order to meet future demand with a minimum outlay of capital and without a serious interruption of the plant output. Familiarity with the available plant equipment is imperative in applying research ideas to commercial practice in the most efficient manner and for removing the bottlenecks, which can be often accomplished by minor equipment or operational changes. The type of work handled by the technical service involves the use of well standardized equipment and of a considerable percentage of routine labor.

Persons suitable for guiding scientific research are difficult to find; those who can handle industrial research are scarcer but those who can guide the technical service are rarities. Some persons in high positions may be surprised to know that it is easier to replace them than a valuable research manager or a research chemist because coordination cannot exist without production. Ideals and perfections are not found in nature, and a compromise is inevitable in making selection of the highly competent personnel needed for research. Unfortunately, a non-scientific administrator should not be made a research manager or director because he cannot guide his organization except by relying on somebody else's judgment or on hearsay. He cannot establish his scientific and technical authority among the high class research personnel working for him and maintain the necessary academic and intellectual prestige. By failing to meet these requirements, he reduces himself to the status of a secretary or of a mechanical device which almost any literate person can be.

Research is the dynamic force behind a commercial enterprise. It can be art, science or trade in the hands of the persons handling it. It can create new business and rejuvenate decaying companies; it can keep a company at the average level of progress or it may wipe a company out of existence. Each company, like any single individual, is free to choose its path.

Supply and Needs Better Aligned

CREDIT IS DUE the nation's refining industry for taking a realistic view of the supply and demand situation and doing something about it. Recent weeks have seen a considerably brighter outlook develop as reduced refining rates, coupled with the year's higher oil demand, have set product stocks in better alignment with immediate future needs.

Sharp reductions in refinry thruput prevented gasoline stocks from reaching volumes that would have resulted if operations had been held to the record-breaking February rate. Motor fuel inventories are currently only slightly larger than they were a year before, and consumption is running higher.

Now the industry has an excellent opportunity to avoid accumulation of excessive gasoline supplies, a situation that has presented difficulties the past several years. Industry is now in the relatively low product consuming season of the year. If refinery output can be held to current rates through May, the heavy gasoline consuming season shall have started making inroads into existing supplies making room for a return to the higher producing rates of early year.

Salute to API Refiners

IN ITS 25-YEAR history, we think the Division of Refining of the American Petroleum Institute has reached a position of amazing proportions. The API as a whole is big business; but we in the refining industry are particularly proud of our specialized branch. Organized in 1930, we can say without hesitation that our division is admirably accomplishing its original purpose: "to provide a forum for the discussion of problems particularly pertinent to a specialized branch of the industry."

McConnell

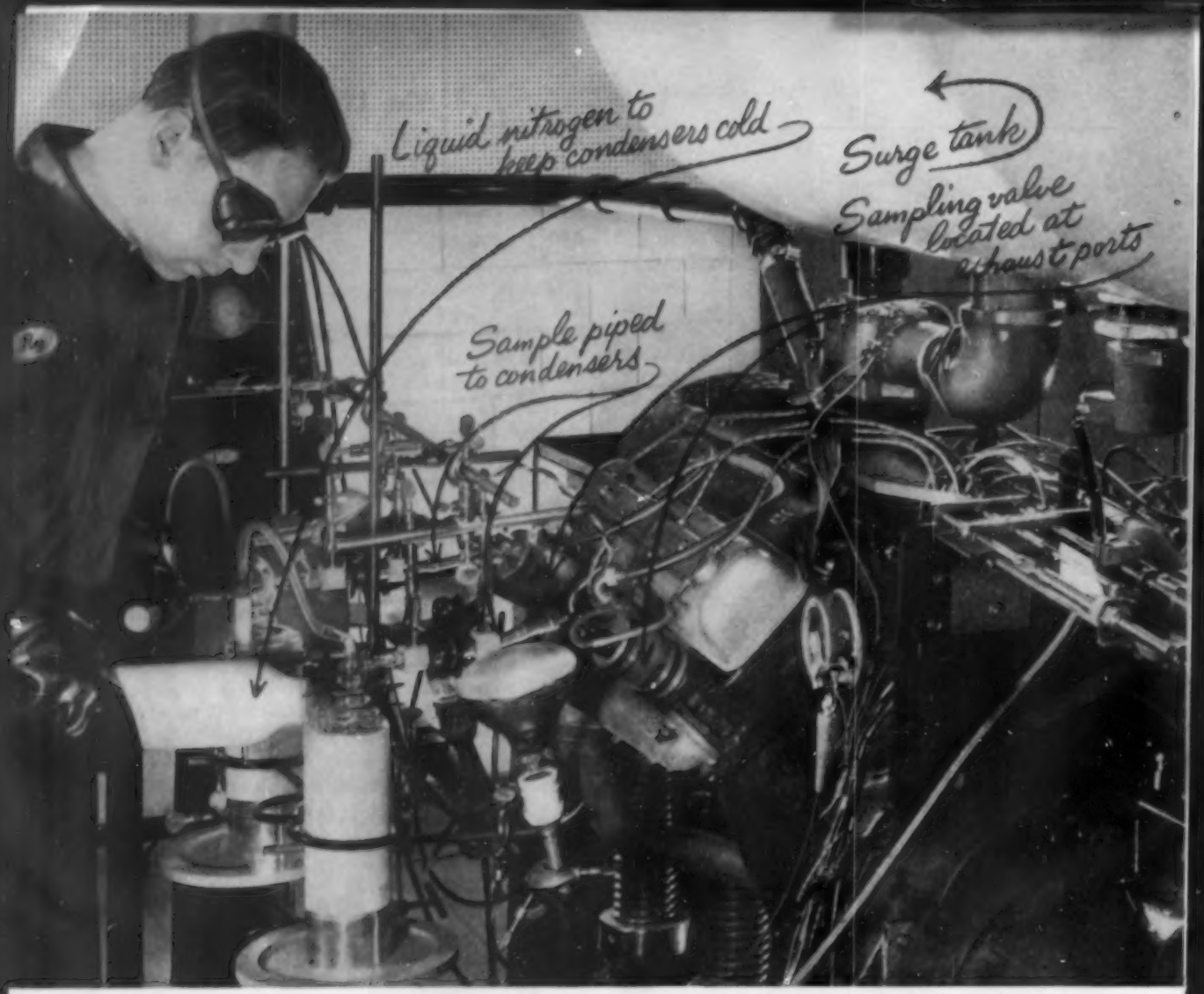
Magnolia's John Newton has said that it is not the committees, not a company or group of companies, not the division, but *people* that form the prime mover. This year we'd like to salute two people in particular—E. B. McConnell, Vice President for Refining and William T. Gunn, Director, Refining Division.

Elected in November to the API post, Mr. McConnell is vice president of manufacturing at the Standard Oil Company (Ohio). He is well-known in the refining industry, he takes his job with a sincerity that makes us all proud.

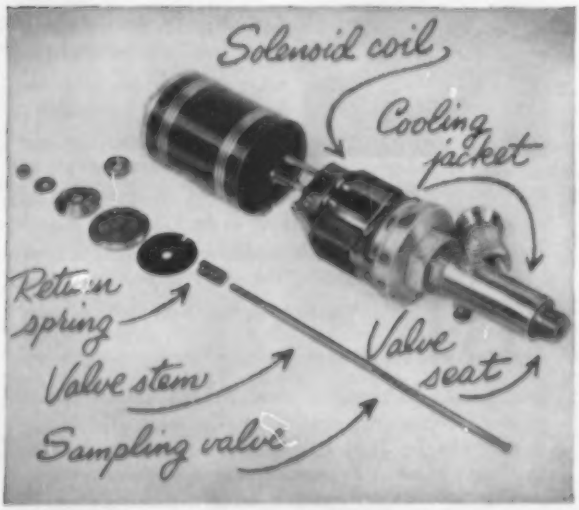
Mr. Gunn has been with the API since 1946, coming to his present post from The Texas Company. His drive as a member of the API staff points to another successful 25 years for the division as we celebrate the silver jubilee this year.

Gunn

In this issue you will find testimony to the efforts of these two men plus all the other people of API. We have selected for publication eight outstanding discussions presented at the Twentieth Midyear Meeting of the Division of Refining at St. Louis this month. To cover completely such an outstanding meeting, we have included abstracts of the other papers presented. This issue is our most sincere salute to the API.


Liquid nitrogen to keep condensers cold
Surge tank
Sampling valve located at exhaust ports
Sample piped to condensers

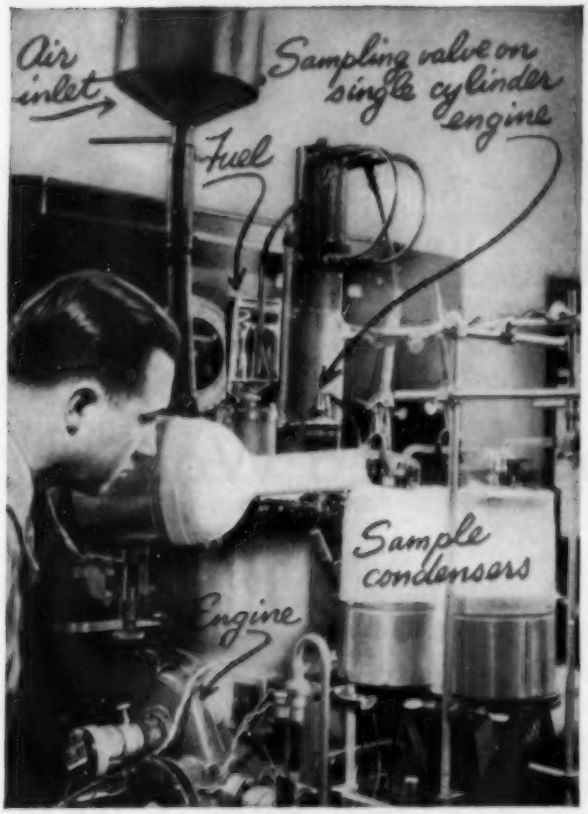
Special instrumentation enables Ethyl Research people to trace fuel distribution to each cylinder, and sample gases at a given moment during combustion. Samples are removed from the cylinders by carefully timed sampling valves.



Exploded view shows tiny electrically driven poppet valve, which is mounted in the cylinder head.

Less than 1/1,000 of a second is required for the sampling valve to open and close.

Heavy hydrogen put to work by Ethyl Research



High-speed sampling technique was developed on single-cylinder engines like the one shown above.

Mass spectrometer, developed by Consolidated Engineering Corp., analyzes the condensate, picking out the "tagged" atoms. This shows how the hydrocarbon mixture was distributed among the various cylinders.

One of the reasons why an engine knocks is this: all cylinders do not receive the same air-fuel mixture—and so distribution of hydrocarbons varies from cylinder to cylinder! Though this may cause knock to occur in only one cylinder, it can boost the antiknock requirement of the entire engine!

How much do the hydrocarbons in the mixture vary from cylinder to cylinder? And what can be done about it?

To track down the answers to these questions, Ethyl Research people assembled a special test apparatus. High-speed sampling valves were inserted in the combustion chambers of a conventional passenger-car engine so samples of the burned gases could be collected from all cylinders.

The test procedure works like this: Various components of the gasoline are "tagged," one by one, by replacing an ordinary hydrogen atom with an atom of heavy hydrogen. The special fuel is then burned in the engine. Samples of the burned gases from the cylinders are collected, condensed and then analyzed in a mass spectrometer. This machine records the presence of the "tagged" components and so gives Ethyl a picture of fuel distribution to the cylinders.

This is part of a program to help refiners manufacture gasolines that will distribute more uniformly from cylinder to cylinder and thus help them control one cause of knock on the road.

ETHYL CORPORATION
Research Laboratories
1600 West Eight Mile Road, Ferndale 20, Michigan
2600 Cajon Road, San Bernardino, California

Save Talents of Handicapped Workers

At Esso Standard, Baton Rouge, they don't confuse physical handicaps with occupational handicaps. A man unable to do one job may do well on another.

Al Reese,
Petroleum REFINER Staff

ONE OF YOUR crane operators loses an eye.

With the best intentions in the world, you shift him to a soft job at the same pay.

Problem solved? Not at all. Accustomed to carrying his share of the load, he becomes restless, dissatisfied, a malcontent and a misfit. He makes no effort to get along with his fellow workers, and their dislike for him may be intensified by the fact that he is drawing full pay for half a job.

What to do? Lay him off? Sit back and let the problem eat into your plant's efficiency?

This is a situation Esso Standard Oil Company's Baton Rouge, La., refinery tries to avoid. In this particular case they might make a happy, productive pipefitter out of a frustrated ex-crane operator who is a dead weight on the payroll and a demoralizing influence.

Probing the Problem—Esso's technique had its beginning several years ago when management recognized the problem. The principal person to recognize that a number of employes were not able to carry their weight because of physical limitations was W. W. Weldon, assistant manager of Employe Relations. He talked about it so much that management decided to do something about it. Charles Leet, then assistant general manager, and Weldon formed a committee, together with the refinery medical director, Dr. Howard Hansen, and others. After working with a number of individual cases, they enlisted the aid of a member of the Mechanical Engineering Department, W. R. Thayer, to assist in organizing the program. With Thayer's help, the group looked into history for how society has treated its physically handicapped. They inquired into the methods employed by state and federal vocation rehabilitation agencies.

They found that although a number of different approaches had been tried, most of them did not seem to fit the refinery situation and the company's basic philosophies on human relations. One approach, however, developed by Bert Hanman,* seemed to

* "Physical Capacities and Job Placement," Bert Hanman—Personnel Research, Berkeley, California, 1951. Nordish Rotogravys, Stockholm, Sweden—(John de Graff, N. Y.—U. S. Distributor).

closely approach what was wanted and was used as a basis for setting up the Baton Rouge program.

First, the group set about removing the blocks to objective thinking caused by using the term "handicap" in too broad a sense. In reality, there are two general types of handicaps, they realized—physical handicaps and occupational handicaps. A physical handicap is defined as a "human limitation from the medical point of view," and an occupational handicap as a "lack of ability to fill all of the requirements for a specific job." Only a physician, with the cooperation of the man himself, can determine the existence of a physical handicap. But both the physical ability of the man, plus the physical requirements of the job, determine an occupational handicap.

The difference can be illustrated by the case of the disabled crane operator. The loss of an eye causes him to become occupationally handicapped, because safe and efficient operation of a crane requires depth perception, which is impossible without both eyes. This faculty, however, is not needed by a pipefitter, as witness the fact that there are several pipefitters with vision in only one eye doing good work in the Esso refinery. Thus, transfer the crane operator into the Pipe Department, and after suitable training his occupational handicap disappears.

They helped install talent-saving program . . . .

Howard Hansen | Robert E. Smith | W. R. Thayer

A more common physical lack which is generally considered a minor physical disability but which may be a severe occupational handicap is color blindness. The man without this faculty makes a good boilermaker but would be a total failure as an electrician because of his inability to distinguish between red and green wire wrappings.

Drafting a Program—Having thus distinguished between "physical handicap" and "occupational handicap," the group at Esso drafted the premise upon which Esso's program has its foundation. It is that while one job situation causes a man to be occupationally handicapped, another job situation does not. Granted there is little or no control over physical handicaps, considerable influence can be exerted over occupational handicaps.

The next step was to acquire information on the physical abilities of the men with physical limitations. It was also necessary to know the detailed physical requirements of jobs in the plant. With these two types of information it would be fairly easy to compare the abilities of each man with the requirements of a job, and so determine what jobs were best suited physically for each man.

A physical capacities analysis was worked out under the supervision of Dr. Hansen, medical director at the refinery. The analysis consists of an easy-to-understand form which, when filled out, supplies exact information on a man's physical abilities.

The second type of information needed is supplied by a physical demands analysis form, which uses terms identical with those on the physical analysis form and which, when filled out, gives an exact description of the physical requirements of a job. The initial job analysis program was undertaken in the Mechanical Division, with the assistance of Robert E. Smith, the general foreman of the Pipe department, and Thayer. Subsequent analyses were made among all of the other craft departments.

When the job analysis forms were completed, they were meshed in with the physical capacities analysis forms completed by the Medical department. Once activated, the program proved that there was an existing job which met the physical capacities of almost every employe under study—

NAM Would Remove Barriers Against Handicapped Workers

The National Association of Manufacturers has proposed "action on the broadest possible front" by employers to eliminate remaining barriers to the employment of people with physical handicaps.

The proposal was made in a new "Guide for Employers in Hiring the Physically Handicapped," prepared by a committee of industrialists in response to the expressed wishes of employers "for guidance in employing and placing the handicapped individual in productive work."

The 32-page guide describes step-by-step procedures which industry has found successful in matching handicapped workers to jobs which they can do as well as able-bodied persons.

In the foreword President Henry G. Riter, 3rd, said the guide was offered as "another step forward in the Association's vigorous campaign to open the doors of industrial employment to men and women with physical impairments." He expressed the conviction that "more employers will hire more handicapped employes when they know how to go about doing it."

The handbook contains detailed suggestions covering company policy; recruiting, interviewing and placing of job applicants; the training of employes; and followup procedures to assure satisfactory job performance, safety, and a feeling of well being on the part of the new employe.

Copies of the guide are available from the National Association of Manufacturers, 2 East 48th St., New York 17, at 50 cents each.

a job he could handle with as much effectiveness as a man without a physical handicap.

One problem remained—how to place each man on the job he could do without leaving men already assigned to those jobs with a feeling of dislocation. The displaced men had to be pleased about their new jobs, too, and the foremen in whose groups the changes were made had to be satisfied.

This was readily solved through good communications. A member of top management explained in detail

to officers of the union and union representatives in the departments in which the project was to be undertaken the plans and objectives which it was hoped would be attained. Every man affected was informed well in advance of the projected changes and told why they were to be made.

"I am glad to say," Smith now reports "that every man in our department who was asked to change from a job in favor of a man who could handle the job effectively in spite of his handicap, did so gladly."

Smith tells of a member of the maintenance group with the Fire Marshals who was asked to transfer to a similar pipefitter job in another department. He was told that an older man who had an allergy could then be moved from an area unsuitable to his condition.

The employe promptly agreed, and added: "I'm glad to be working for a company that looks after its employes this way . . . it's mighty encouraging to know that if ever I need the same kind of help, I'll be getting it." ##

Worldwide Activity Bolsters Earnings of U. S. Oil Firms

Aggregate increase in profits shown for 1954. Other companies experience combined decrease.

U. S. OIL COMPANIES with large foreign operations, as a group, had a relatively more profitable year in 1954 than other companies, in the aggregate. This is one of the facts indicated by a tabulation of the earnings of 36 U. S. oil companies in 1954, compared with 1953.

Five large U. S. oil companies, operating worldwide, reported combined net income of $1,389,425,406 in 1954, an increase of 4.8 percent over the

See EARNINGS, page 275

Net Earnings of U. S. Oil Companies

Company	1953	1954	% Dif.
Companies with Large Foreign Operations			
Gulf Oil Corporation	$ 175,036,136	$ 182,813,045	+ 4.4
Socony-Vacuum Oil Company	187,250,228	183,805,995	— 1.8
Standard Oil Company of California	189,453,450	211,872,447	+11.8
Standard Oil Company (New Jersey)	581,007,661	584,793,158	+ 0.6
The Texas Company	192,600,078	226,140,761	+17.4
Total, 5 Companies	$1,325,347,553	$1,389,425,406	+ 4.8
Other Companies			
Amerada Petroleum Corporation	18,445,590	19,777,647	+ 7.2
Argo Oil Corporation	4,212,290	4,288,870	+ 1.8
Atlantic Refining Company	49,755,124	41,350,565	—16.9
British American Oil Company, Ltd.	19,735,437	18,159,114	— 8.0
Cities Service Company	50,720,779	43,724,163	—13.8
Continental Oil Company	40,874,666	41,683,189	+ 2.0
Deep Rock Oil Corporation	1,530,825	2,480,999	+62.1
Houston Oil Company of Texas	6,709,844	6,487,785	— 3.3
*Humble Oil and Refining Company	164,257,854	146,302,708	—10.9
Lion Oil Company	10,688,260	11,071,426	+ 3.6
Mid-Continent Petroleum Corporation	14,394,239	13,468,497	— 6.4
Ohio Oil Company	43,539,172	38,223,725	—12.2
Phillips Petroleum Company	76,760,231	76,234,679	— 0.7
Plymouth Oil Company	8,059,078	6,759,061	—16.1
Pure Oil Company	27,104,723	31,163,000	+15.0
Richfield Oil Corporation	28,875,486	25,570,701	—11.5
Seaboard Oil Company	6,540,132	7,470,307	+14.2
Shell Oil Company	115,406,585	121,126,546	+ 5.0
Signal Oil and Gas Company	9,266,196	9,313,280	+ 0.5
Sinclair Oil Corporation	68,061,006	74,623,256	+ 9.6
Skelly Oil Company	31,276,785	29,455,250	— 5.8
South Penn Oil Company	6,217,648	5,056,904	—18.7
Southern Production Company	3,601,367	4,173,767	+15.9
Standard Oil Company (Indiana)	124,826,397	117,156,768	— 6.2
Standard Oil Company (Ohio)	21,217,675	18,527,085	—12.7
Sun Oil Company	45,153,602	40,343,791	—10.7
Sunray Oil Corporation	27,572,827	23,200,139	—15.9
Texas Gulf Producing Company	4,230,659	5,245,527	+24.0
Texas Pacific Coal and Oil Company	7,599,068	7,856,034	+ 3.4
Tide Water Associated Oil Company	36,951,568	34,547,239	— 6.5
Union Oil Company of California	38,099,602	35,887,920	— 5.8
United Gas Corporation	25,659,815	26,749,356	+ 4.2
*Total, 31 Companies	973,086,676	941,176,590	— 3.3
*TOTAL, 36 Companies	$2,298,434,229	$2,330,601,996	+ 1.4

* Humble is excluded from totals, being included as a subsidiary of Standard Oil Company (New Jersey), which owns 86 percent of Humble stock.

Products Session

What We'll Be Making in 10 Years

The refinery of 1965 will be quite different from today's set-up; here's a look at the way product demand will change.

Arthur L. Lyman,
California Research Corporation,
San Francisco

FORECASTERS agree that total petroleum demand on U. S. refineries will continue to increase and will reach slightly over 11 million barrels daily by 1965. This forecast is largely an extension of the trend since 1925, but at a lower annual rate of increase (3.3 percent forecast compared with 4.4 percent since 1925). Present refinery capacity will have to increase at a corresponding rate to meet the future demands. Figure 1 shows the total petroleum demand on U. S. refineries from 1930 to 1965. Total petroleum demand on U. S. refineries is the base point for this paper. In addition to crude processed, it includes natural-gas liquids and liquefied petroleum gas, although a considerable fraction of these do not physically pass through the refineries. As we are primarily concerned with trends, this basis is satisfactory for our consideration. Figure 1 also shows the increasing demands for gasoline, distillate fuels, residual fuels, and "other" products. This increasing demand will require more crude production, and we may assume that, with a vigorous exploration and development program and with adequate imports, there will be no crude supply limitation on our refineries.

With the passage of time there will be changes in the demand for products as a percentage of total petroleum run, the principal one being a continuation of the reduction in yield of residual fuels. Figure 2 shows the yield of various products as percent of total petroleum demand from 1930 to 1965. We are all familiar with the spectacular increase in gasoline yield during the late 1920's and early 1930's and the corresponding drop in residual fuel. Gasoline will remain the largest volume product and will account for about 45 percent of total petroleum demand. Distillate fuels have constituted the second largest class of products since 1951, at which time residual fuels fell to third place.

Of much greater significance to the individual refiner will be the changes in product quality and formulations, and these changes will largely set the pattern for refinery operations for the future. The trend toward higher octane gasolines will continue, and many motorists will be demanding 100-octane fuel before 1965. In order to meet this trend, catalytic reformers are being installed at a rapid rate; and this will bring the total installed catalytic reforming capacity near to a saturation point before 1960. Another factor, better tetraethyllead response with lower sulfur content, coupled with the availability of hydrogen from catalytic reforming operations, will result in wider application of sulfur removal processes.

The various products will be discussed separately and

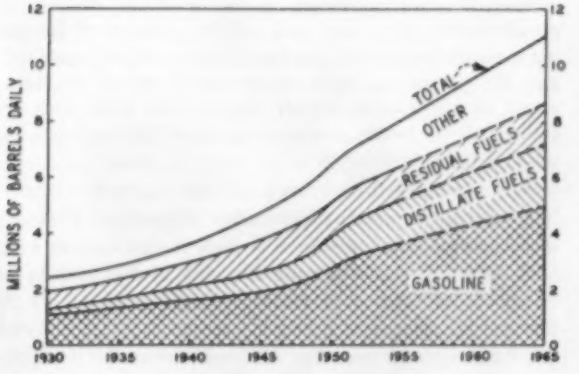


FIGURE 1—Demand on U. S. refineries: Yesterday and tomorrow.

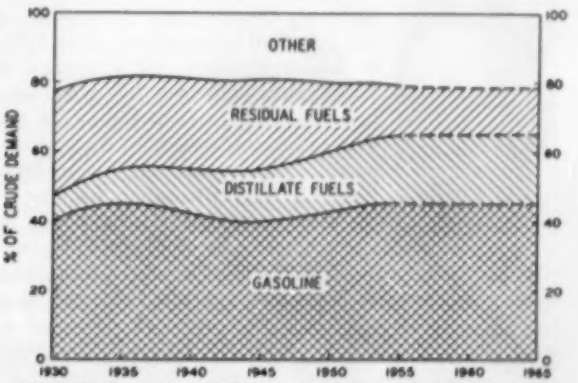


FIGURE 2—Demand on U. S. refineries: Less residual in the future.

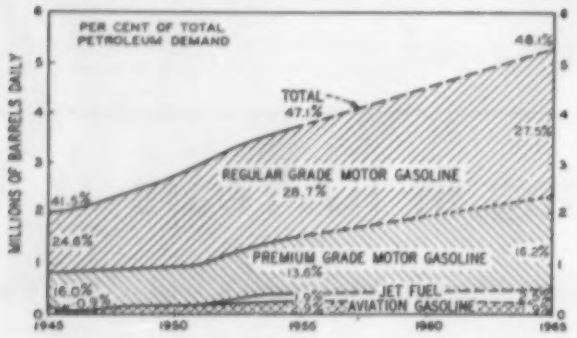


FIGURE 3—*Gasoline demand*: A bigger part of crude.

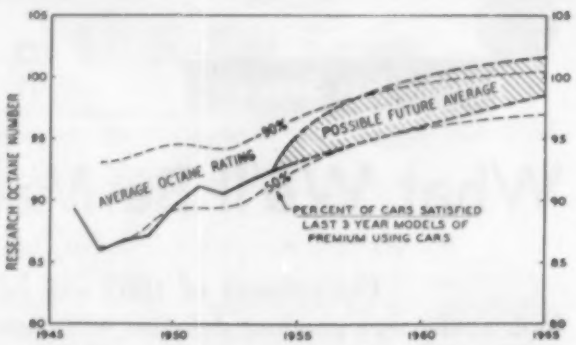


FIGURE 4—Premium gasoline octane number trends: Upward.

in more detail to point out some of the future problems the refiner must face.

Gasoline—First, gasolines are considered with respect to what has happened during the past 10 years and what may be expected during the next decade. Jet fuel is considered with gasolines because of the preference of the military for the volatile type of fuel and the probability that civilian use of the kerosine type will be relatively small, even by 1965. Figure 3 shows the dema.. t for regular motor gasoline, premium motor gasoline, aviation gasoline and jet fuel, and the percentage of each for the years 1945, 1955, and 1965, relative to total petroleum demand on refineries. These curves show a motor gasoline demand upwards of 4.5 barrels daily by 1965, of which one-third will be premium quality. It is interesting to note that aviation gasoline demand is expected to decline very slowly, with jet fuel supplying the increasing demands of a growing aviation industry, first military and later civilian. Aviation-gasoline quality requirements are expected to remain high, with over 90 percent of the demand being for grades in excess of 100 octane. Thus, the advent of the jet engine will have little effect on the demand for high quality aviation gasoline as it will be used to power a new and more powerful type of aircraft. Further, there will be no significant contribution to motor-gasoline octane quality from excess aviation-gasoline capacity.

The most important change in gasoline quality during the past 10 years has been in octane number, and this change is expected to continue. Figure 4 shows the trend of Research octane number as it has occurred, plus a prediction of where it will go from here. The lower line of the prediction is a simple extrapolation of the previous trend, and the upper portion is based on competitive forces. These forces are already at work, and there are now many commercial, first-structure gasolines in the 95 to 98-octane-number range.

Figure 4 also shows an extrapolation of octane requirement trends. Each point is based on the last three years' car models, prorated in accordance with production, of several makes of premium-gasoline-burning cars. Attention is called to the fact that the average of these future cars should be satisfied by the gasolines of the future, because the 50 percent satisfied line is below the predicted octane number range. However, to satisfy as high a proportion as 90 percent of these cars, gasoline some 4 octane numbers higher will be required. It, therefore, seems safe to predict that there will be detonation in a substantial number of cars. Hill climbing will exaggerate this by raising octane requirements by 2 to 4 octane numbers. On the other hand, the use of 10W/30 oils and other new products to come, both oils and gasolines, will tend to reduce octane requirement increases. Thus, the octane requirements of future cars will be influenced by the octane numbers of the gasolines which can be produced, and the octane numbers of the gasolines will be influenced by the cars in which they will be used. The net result will be better performing, more economical cars, using better gasolines.

To the refiner this means a continued growth of catalytic processes, principally catalytic reforming. Figure 5 shows the past and predicted growth of thermal cracking and reforming and catalytic cracking and reforming in terms of per cent of gasoline produced. The growth of thermal cracking and reforming required 20 years to 25 years to reach an apparent saturation point in 1940. Although the primary advantage of thermal cracking was

Meet the Author

ARTHUR L. LYMAN, who presented the accompanying article during a session on petroleum products at the API Division of Refining's meeting in St. Louis, is president of California Research Corporation. A member of the Standard organization since 1924, he joined Standard Oil Company of California following his graduation from the University of California and worked in the Research & Development department until his appointment in 1931 as assistant manager of the Richmond laboratories, which he was named to head in 1938. He was elected a director of California Research Corporation when it was organized in 1944, appointed vice president and director of laboratories in 1946 and promoted to executive vice president in 1953. He has been president since 1954.

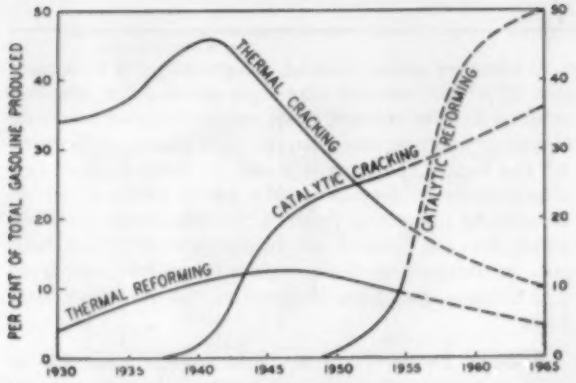


FIGURE 5—Gasoline processed by thermal and catalytic processes: More cat reforming than cat cracking.

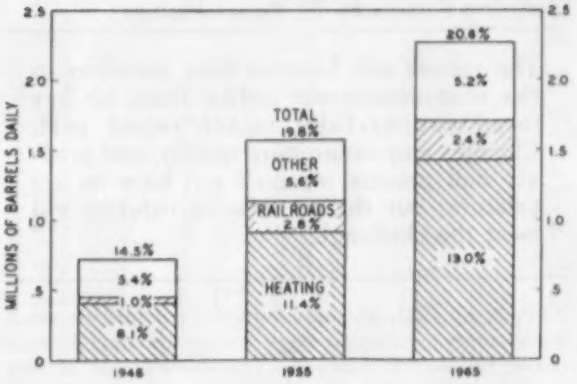


FIGURE 6—Total U. S. demand for distillate fuels and percent of total petroleum demand.

the shifting of heavier oils into the gasoline range, it did contribute somewhat to the increased octane rating of gasoline. The growth of catalytic cracking has been somewhat more rapid than was the growth of thermal cracking. The principal advantage of catalytic cracking was its improvement in octane rating while maintaining or increasing the shift from heavy oil to gasoline reached by thermal cracking. Now the extremely rapid expansion of catalytic reforming is evident, although it was hardly a significant factor 2 or three years ago. It seems probable that, by upgrading both straight-run and cracked stocks, catalytic-reforming capacity may soon surpass catalytic-cracking capacity for gasoline production.

Maximum utilization of catalytic reforming and cracking by refiners will permit production of gasolines of high octane value, but perhaps not high enough. We can reach an octane level of 98 or 99 for average premium grade by utilizing catalytic cracking and reforming to the fullest extent now considered possible. Perhaps improved catalysts will permit us to exceed the 100 octane level before 1965. It seems probable, however, that new processes will have to be developed to meet the future high octane levels beyond the ability of catalytic reforming. Furthermore, it is not probable that this upward octane trend will reverse or be superseded by some new automotive development during the next few years. Jet engines, several years after appearing in significant numbers, have only now apparently stabilized aviation gasoline quantity and quality trends. Replacement of the piston-powered automotive engine by some comparable development, in significant numbers, is not expected, at least in the immediate future.

A number of other factors will increase refinery complexity, as well as manpower and special equipment requirements, even though they do not bring forth increased gasoline volume. Octane number, while a most important gasoline property, is only one of the factors which make up gasoline quality. Volatility and vapor pressure, for example, are also very important performance properties. Increase in engine horsepower has been brought about, in part, through "improved breathing"; i.e., by increasing induction system capacity. This engine modification has considerably worsened cold-starting and warm-up characteristics of present automobiles. To date this difficulty has been offset by operation of automatic chokes over longer periods. A more desirable solution is the use of fuels with more volatile front ends. If recent improvements in automobile fuel handling systems can be extended further so as to minimize vapor-lock difficulties, it will be possible to raise the vapor pressure and front-end volatility of gasolines in this manner. The supply of butanes which would normally be used for this purpose should be ample, from increased natural-gas production and catalytic-refining processes.

The use of additives to improve gasoline performance characteristics has received much attention recently. Effective additives have been developed to prevent rusting of fuel systems, eliminate carburetor throttle body gumming, reduce ice formation in wet fuels and in carburetors, retard development of gums during storage, and reduce one of the causes of surface ignition. The success which has been achieved in improving engine fuels by use of additives has resulted in an increased level of technical effort to improve many other important performance characteristics by this means. In the future the refiner can expect to be more involved in handling special chemicals and blending into gasolines relatively minor, but accurately controlled, amounts of these special materials.

It has become apparent that a better understanding of the importance of gasoline gum content on fuel performance and storage is needed. Some of the existing gum-content specifications and test methods have been found to have little significance from a service-performance standpoint. As research efforts bring forth improved gum specifications based upon meaningful laboratory tests, it is quite possible that it will be necessary to alter either gasoline finishing methods or the type and amount of antioxidant additives.

Automobile developments, which, if successful, could have an influence on future gasoline refining trends, are development of the gas turbine and new methods of introducing fuel into spark ignition engines. The automotive gas turbine is not likely to be a significant factor in fuel requirements within the next five years; even if manufacturers were tooling up now to mass produce an automotive gas turbine, the number of these units on the road by 1960 would constitute a minor percentage of the total. This situation could, however, become quite

The refiner will have to face problems in the next decade not unlike those he has faced successfully in the recent past. Changes may occur more rapidly, and product and process research will have to accelerate; but the oil refining industry will meet the challenge.

different by 1965. Should automotive gas turbines reach the quantity production stage, refinery product balance would be altered markedly. The development of new methods of introducing fuel into automobile engines, such as by direct cylinder injection, also is not expected to advance sufficiently to exert a significant influence on gasoline requirements in the next five, and probably not in 10 years. However, if successful, these technical efforts ultimately would alter the octane trend and would have a marked effect on volatility requirements.

Distillates—The total demand for distillate fuels is not expected to continue its rapid rise of the past 10 years but will increase rather slowly above 20 percent of total petroleum demand on U. S. refineries. The trends for distillate fuels are shown in Fig. 6, which also shows the trends for the two major end uses—space heating and railroad diesel fuel. Dieselization of the railroads is largely complete, and future trends for all distillate uses will follow a normal growth pattern. As in the case of gasoline, yields trends are secondary to quality and composition changes.

Diesel fuels containing catalytically cracked components are in common use as a result of research which has been successful in overcoming the performance shortcomings of these petroleum fractions. This success has motivated extensive research directed toward additional improvements in catalytically cracked distillates. Production of diesel fuels containing cracked stocks and of equal or better quality than straight run refined products soon will be possible. This will be obtained either by an expanded use of additives in diesel fuels or broader use of new distillate treating methods. Processes for the reduction of sulfur in premium diesel fuels will show some increase in the next few years, partly as a result of the availability of byproduct hydrogen from catalytic reformers. However, the use of fuel additives, better lubricants, improved metallurgy, and improved engine design will tend to reduce the necessity for process modifications.

Railroad use comprises about 40 percent of the total diesel fuel requirements. Recently, railroads have shown great interest in the use of residual fractions in fuels intended for medium speed diesel engines. Under conditions of high power output, many railroad engines will operate reasonably satisfactorily on fuels intended for medium speed diesel fuels. Under conditions of high power output, many railroad engines will operate reasonably satisfactorily on fuels containing residuum. However, means must be developed for improving combustion under idling and low load operating conditions before extensive use of residual components will be attractive. If present research efforts are successful in adapting residual fuels to railroad diesel engines without incurring excessive maintenance costs or operational difficulties, we can expect the current trends in railroad diesel fuel requirements to decrease as the use of residual fuel increases. An interesting result of this situation is the probability that gas turbines will encounter even greater difficuly in supplanting diesel engines on an economic basis if it is found that diesel locomotives can burn lower cost fuels.

Residual Fuels—The past rapid reduction in yield of residual fuels from crude will continue, but at a slower pace. By 1965, although use will have increased by almost 50 percent, residual fuel demand on U. S. refineries will be 13 percent of the total petroleum demand on refineries. This is about half of the percentage of 1946 (the earliest postwar period for which statistics are significant.) Figure 7 shows these trends, along with some major end uses. Figure 7 also shows total residual-fuel demand of the United States which exceeds the residual-fuel demand on U. S. refineries by the amount of imports. The requirements for residual fuel by the utilities is expected to increase 20 percent in the next 10 years and will probably increase further before atomic energy begins to become significant in the power-generating field. It is in this and the ship-propulsion fields that atomic energy will first supplement fossil fuel as sources of energy.

The gradual decline in percentage demand of residual fuels will probably be accomplished by increased utilization of present processes for shifting heavier oils into the higher gravity ranges. Much wider use will be made of vacuum stripping for straight run and cracked residua, and coking units of new types will become more popular.

The inorganic constituents which accompany most residual fuels account for the main technical difficulties in burning residuals in gas turbines or diesel engines. Research is very active in attempting to remove the inorganic components or to neutralize their harmful effects. Moderate success in these efforts undoubtedly would lead to new types of refinery operations. Should dual-fuel systems provide the solution to maximum utilization of residual components in diesel engines, the compatibility characteristics of residuals upon mixing with distillates will become important. It may be found necessary to restrict the composition of residual fuels to insure compatibility, and this development could have a great influence on refinery handling and segregation of residual components.

Other Products—Kerosine, lubricating oil and grease, liquefied petroleum gas, asphalt, and coke are very important petroleum products, although their volumes are minor. The trends of demand and percentage related to total petroleum demand for these products are shown in Figure 8.

The demand for kerosine is expected to level out at 350,000 barrels daily for several years, but the yield will drop to less than 4 percent. This demand is 10 times that of 1915, a time when kerosine was considered a major

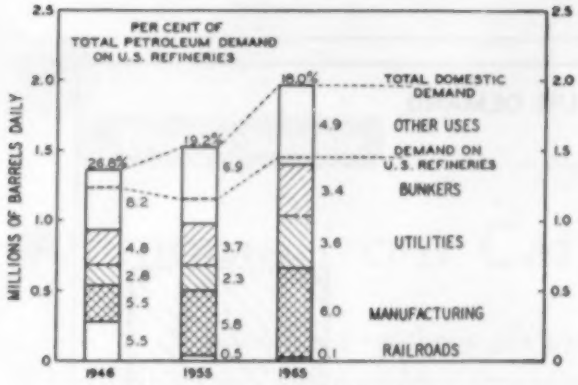


FIGURE 7—Total U. S. demand for residual fuel oil.

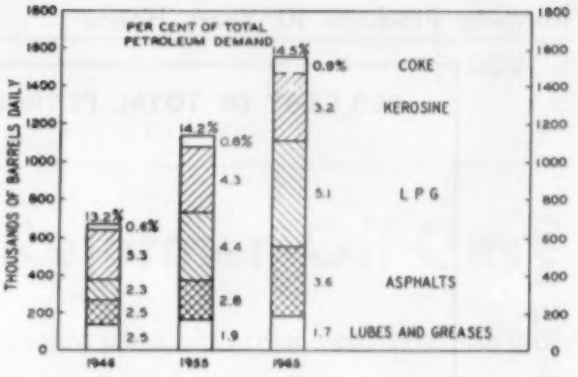


FIGURE 8—Total U. S. demand for minor products: More LPG and asphalt.

product. Even if commercial airlines select kerosine as fuel for future jet transports, the effect on demand will not be great. No substantial quality changes in kerosine are anticipated.

The demand for lubricating oils and greases will increase moderately, but will show a slowly decreasing percentage yield because of the effect of mechanical design improvements in the mechanisms using them. Overshadowing these trends is the very rapid advance in quality levels attained through the use of special compounding materials and additives. These quality improvements will continue to advance at least as fast as advances occur in engine design. The refiner, therefore, will find it necessary to handle an increasing number of special compounding and additive materials. The use of viscosity index improvers in oils for uses other than automobiles is probable; this will result in an expanded use of neutral oils and a corresponding reduction in the use of bright stocks.

It is possible to control the corrosive wear of engines by means of improved lubricating oil additives or, perhaps in the future, by entirely new types of lubricating oils. Thus, the fuel-sulfur problem mentioned before can be solved in a large measure by use of the proper engine lubricating oils, although it is expected that engine builders will recognize and avail themselves of mechanical means of ameliorating the problem. The use of additives in lubricating oils is probably more economical than the use of new, expensive processes for removing sulfur in fuels.

Synthetic lubricant developments are not expected to have a marked effect on requirements for petroleum-derived lubricants. Special lubricant applications will require an increasing volume of synthetic lubricants, but only in military applications will this volume become significant in the near future.

The demand for liquefied petroleum gas shown in Figure 8 is from all sources, and refineries will have to meet about 35 percent of this requirement. One of the major uses of liquefied petroleum gas will be as a raw material for petrochemicals based on light aliphatic hydrocarbons.

The demand for and yield of asphalt will show a substantial increase, largely as a result of the ambitious highway building program planned in this country. Specifications for paving asphalts will probably undergo many changes as the result of extensive research which even now is defining more precisely the factors important to asphalt quality. These specification changes will undoubtedly result in modifications to present manufacturing processes, but it is too early to predict what these changes will be.

A moderate increase in demand for petroleum coke will occur, based on its usual outlet for induction furnace electrodes. Considerable increase in demand could occur if petroleum coke should enter the metallurgical field. However, this is not considered probable.

Whereas the increase in volume of the many special petroleum products will not be large in comparison with the increases in volume of products utilized for energy purposes, the manufacture of nonfuel products will become increasingly more complex and diverse. Unique properties of new additive materials which make them outstanding contributors to oiliness extreme pressure resistance, antirusting, oil thickening, oxidation resistance, and the like are being explored continually in many laboratories. This work will bring forth a continuing stream of product improvements and some entirely new products. This specialty field may show a growth only slightly less spectacular than that of petrochemicals.

Petrochemicals—What effect will the rapid growth of the petrochemical industry have on the petroleum refiner? Volumewise, very little; forecasts contained in the Paley report indicate only approximately 1.3 percent of total oil and gas production will be required for petrochemicals in 1965. Most of the hydrocarbons required for petrochemicals are aliphatic—ethane, propane, and butanes and their homologues. As the amount of natural gas produced will increase and the amount of light hydrocarbons from catalytic processes will greatly increase, there will be a negligible effect on the refiner from increased demand for aliphatic hydrocarbons for petrochemicals.

However, according to the Paley report, an increasing percentage of aromatic hydrocarbons, the large majority of which are in the gasoline boiling range, will be required for petrochemicals. If these forecasts are correct,

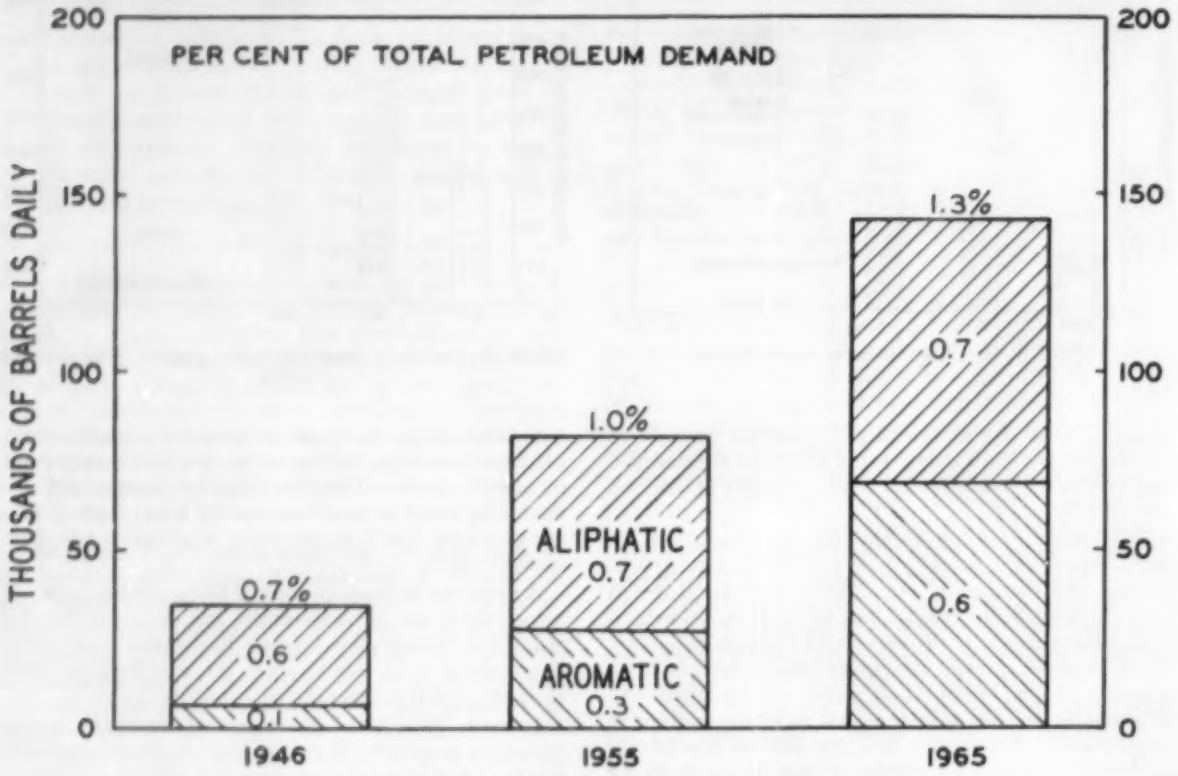


FIGURE 9—U. S. petroleum demand for petrochemicals: Still a small percent of crude.

the refiner will have even greater difficulty meeting the demand for high octane aviation and motor gasolines because of the high octane blending values of benzene, toluene, and the xylenes. As indicated in Figure 9, which shows the demand for hydrocarbons for petrochemicals, the volume of aromatics will approach that of the aliphatics in 1965 and will be about 70,000 barrels per day. This is approximately 5 percent of the volume of premium motor gasoline, and approximately 30 percent of the aviation gasoline demands forecast for 1965. If these aromatics are required, they will have to come from wider application of the same processes which will be required to meet the high octane gasoline requirements or may have to be supplied from coal.

Original presentation was before the API Division of Refining Meeting, St. Louis, May 12, 1955.

More about Petroleum Products

Labeling: A fast moving technology can create new hazards, and progressive medical science can uncover old ones. The practice of protective labeling, long used in the chemical and drug industries, can provide safeguards against unconscious misuse of petroleum products. Areas of potential hazard may be skin contact, inhalation, ingestion, or use under conditions where fires may occur. Some states have already passed laws making labeling mandatory.

The common-law aspects and general provisions of such laws were discussed and examples were given of suitable labels. Comments were made on how a protective labeling program may be implemented to the advantage of both manufacturers and users. The responsibility for implementing a labeling program in an oil company should rest chiefly with a qualified industrial hygienist, assisted by the legal, manufacturing, marketing, and medical departments. ("Protecitve Labeling of Petroleum Products," L. C. Beard, Jr. and A. C. Pabst, Socony-Vacuum Oil Company, Inc., New York.)

Heavy fuel oils: A new look at residual fuel quality is necessary in the light of more stringent performance requirements. More critical demands have been placed on residual fuel in power-plant operations because of the trend toward higher pressures and temperatures, reduced boiler size for a given capacity, and the advent of residual-fuel-burning gas turbines. Railroad and marine diesel engine use of residual fuel, or of blends of residual and distillate fuel, has also brought new qualities into prominence. The effects on quality of declining yields of heavy fuel from domestic crudes, greater imports of South American fuels inherently higher in vanadium content, and modern processing methods were described. The need for closer cooperation in the future between designer, operator, and fuel oil supplier was stressed. ("A New Look at Heavy Fuel Oils," J. O. Collins and W. T. Knox, Esso Research and Engineering Co., Linden, N. J.) ##

Process Session

Ammonia from Cat Reformer Off-Gas

Six ammonia synthesis gas preparation processes are compared on the basis of production costs and operating characteristics.

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THE REFORMING of petroleum naphthas over a platinum catalyst for the production of motor gasoline or aromatics yields, as a byproduct, an off-gas usually containing between 77 and 95 mole percent hydrogen. The recent rapid increase in the number of catalytic-reforming installations has, through this off-gas, produced a large source of hydrogen which up to a few years ago was not available to the average refiner. In 1954 alone, approximately 70 catalytic reformers were either built or under construction.

The amount of hydrogen utilized by the typical refining uses is, at present, small compared to the amount of hydrogen available. These processes for the use of reformer off-gas hydrogen can ordinarily utilize the gas as it comes from the reforming unit without purification. Some of the more attractive uses for this hydrogen are ammonia production, its use as bottled hydrogen, or the hydrogenation of vegetable oils which demand a high-purity product and are not ordinarily considered by the refiner. Of these uses, ammonia production shows the most promise at present for the utilization of large amounts of catalytic reformer hydrogen. Other than the small amount of hydrogen consumed in hydrodesulfurization operations and in the upgrading of cycle stocks, this is the only appreciable use being made of reformer off-gas hydrogen at the present time. Since ammonia production appears to be the major future use of byproduct hydrogen, all of the hydrogen-recovery processes described in this paper were designed with respect to producing ammonia as the end product.

It should be noted that, of the various hydrogen-recovery processes to be outlined in this discussion, only a few are suitable for producing a high-purity hydrogen stream. In the others it is an inherent part of the process that nitrogen is introduced. However, this nitrogen is not considered as an impurity for ammonia production as long as the hydrogen-to-nitrogen ratio in the final stream is greater than three to one. Thus a discussion of those recovery processes which produce only pure hydrogen would have excluded some methods for the production of ammonia synthesis gas.

Off-Gas Composition—A study was made in order to determine the range of gas composition which is produced in the course of ordinary refinery operations. A comparison of the actual off-gas compositions from a large number of operating units shows that the extreme limits of reformer operation produce off-gas ranging between approximately 77 and 95 percent hydrogen. It was decided that each ammonia process would be considered at conditions covering the entire range of reformer operation. For this reason three typical gas compositions were picked which cover the range of hydrogen compositions discussed. These 3 typical gas compositions are given in Table 1. The gas stream containing 77.7 percent hydrogen was the lowest-hydrogen-content gas found from actual operation. It is probably as low as would ordinarily be encountered and is typical of only very severe reforming conditions for motor-gasoline production. The 94.2-percent-hydrogen stream was the one with the maximum amount of free hydrogen in the various off-gas analyses studied and was produced from a very mild operation for aromatics production. Between these two extremes, and based on a gas analysis made to illustrate best the gas composition produced by the average reformer operation, is an 85.4-percent-hydrogen stream from a typical motor-gasoline operation.

Although the percent of free hydrogen in the streams varied widely, the ratio of the various C_1 and C_5 hydrocarbon components to one another remained nearly constant in the different gases. This may be observed by comparing the 3 feeds of Table 1. For example, the ratio of C_2 to C_3 for the 3 feeds in the order in which they

TABLE 1
Typical Catalytic Reformer Off-Gas Streams

COMPONENT	Case I (Mole Percent)	Case II (Mole Percent)	Case III (Mole Percent)
Hydrogen	94.2	85.4	77.7
C_1	1.7	5.4	8.7
C_2	1.5	3.8	5.8
C_3	1.1	2.9	4.5
C_4	0.4	1.1	1.8
C_5	0.2	0.5	0.8
C_{6+}	0.9	0.9	0.7
Total	100.0	100.0	100.0
Average Non-Hydrocarbon Impurities	**Parts Per Million by Volume**		
Carbon Dioxide	50	50	50
Carbon Monoxide	10	10	10
Hydrogen Sulfide	300	300	300
Mercaptan	30	30	30

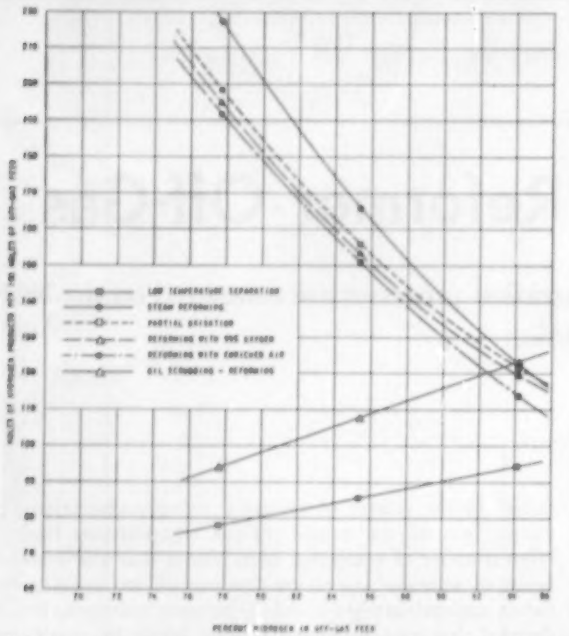

FIGURE 1—Comparison of yield of hydrogen at varying off-gas concentrations.

appear in the table is 1.36, 1.31, and 1.28. On this basis, the results of the material-balance and economic studies made for the three feeds have been plotted (see Figures 1 and 2) with respect to the free-hydrogen concentration of the feed gas only for each of the hydrogen-recovery processes considered. Thus the curves may be utilized for an approximate answer for any reformer off-gas feed based only on its hydrogen content.

The off-gas streams from refinery operation are usually available at approximately 100 F, and this temperature was used for the 3 feed streams. The pressure, however, may vary over a fairly wide range, and 400 psig was taken as an average figure. To keep the comparisons on the same basis as much as possible, the same average non-hydrocarbon impurities were used for all 3 feed streams.

Processing Methods—A number of processes are available for the production of pure hydrogen or ammonia from naphtha reformer off-gas. Six of the most promising methods are considered in this study:

1. Low-temperature separation.
2. Steam reforming.
3. Partial oxidation.
4. Reforming with 95 percent oxygen.
5. Reforming with enriched air.
6. Oil scrubbing followed by steam reforming.

A plant design was made for each process so as to utilize the three respective feeds under consideration. Thus the completed study covers the expected range of reformer off-gases for the six recovery processes. Each process is carried through to the production of ammonia. The same ammonia synthesis section, with minor variations, is used with each of the six methods of synthesis-gas production. This process is shown schematically in

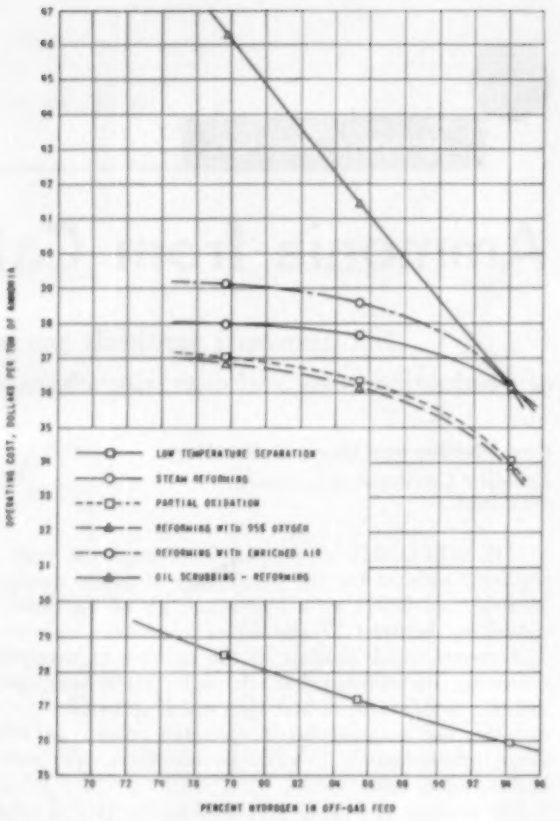

FIGURE 2—Cost of ammonia produced as a function of hydrogen concentration in the off-gas feed.

Figure 9. In the six recovery processes the synthesis gas is delivered at various pressure and inert levels which necessitate small variations in the synthesis section in order to adapt it to each case. Operating requirements, plant investment costs, yield figures and, finally, cost in dollars per ton of ammonia are given for each of the resulting 18 cases. The results are tabulated in Tables 2 and 3 and finally are presented as a plot in which the cost per ton of ammonia is shown as a function of the recovery process and the free-hydrogen concentration in the feed gas. This plot, Figure 2, permits an approximate evaluation of the cost to produce ammonia from any catalytic reformer off-gas.

The present study is based upon the assumption that for any given case sufficient off-gas is available to produce 200 tons of ammonia per day, and all figures are based upon this size plant. However, the yield of hydrogen which would be recovered by any particular process may be of primary importance for a small reformer installation. Figure 1 presents the amount of hydrogen which could be made available by each of the 6 recovery processes as a function of the free hydrogen in the off-gas feed. The yield is given as moles of hydrogen available per 100 moles of total off-gas feed. The hydrogen-yield figures include average expected losses during hydrogen production, but do not include any which would be incurred in further processing to ammonia. Figure 2 shows that steam reforming produces the largest yield of hydrogen per given unit of feed gas. In this process 2.8 moles of hydrogen are produced for every mole of free

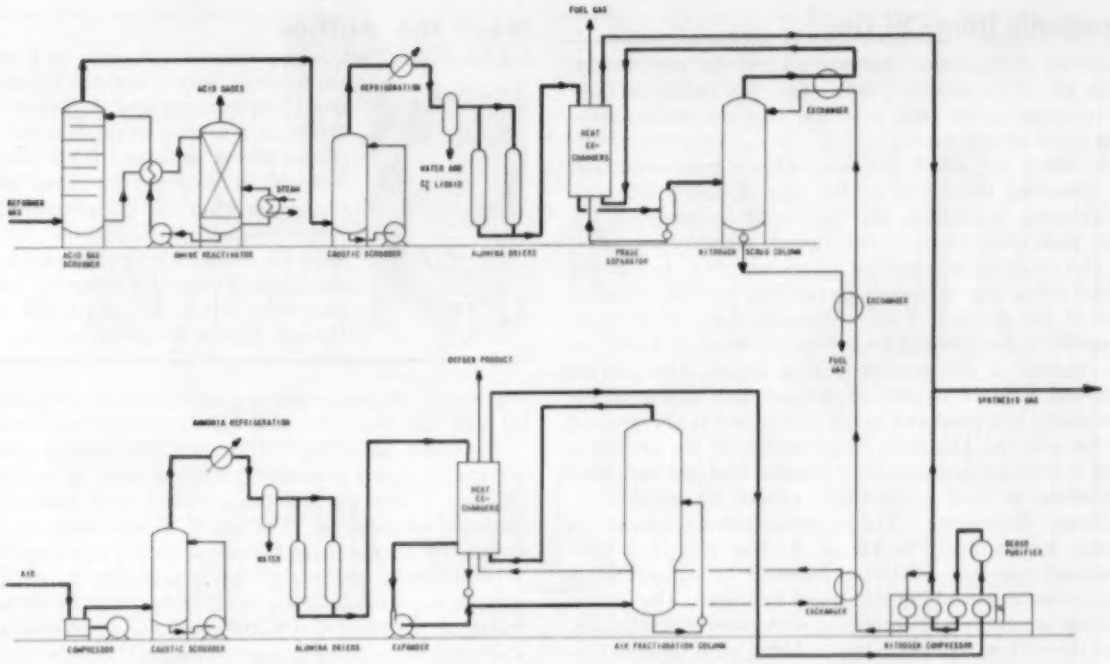

FIGURE 3—Low temperature separation process for preparing ammonia synthesis gas from reformer off-gas.

hydrogen in the feed in the case of the 77.7-percent-hydrogen feed. Low-temperature separation, on the other hand, produces slightly less than one mole of hydrogen per free mole of hydrogen in the 77.7-percent feed. At the other extreme of hydrogen concentration, i.e., 94.2 percent free hydrogen in the feed, the difference in hydrogen yields produced by the various processes is considerably less. Here the low-temperature separation process again produces the least amount of final hydrogen—slightly less than one mole of hydrogen for every free mole in the feed, while steam reforming produces 1.32 moles of hydrogen for every free mole in the 94.2-percent-hydrogen feed.

Low-Temperature Separation: The process scheme for low-temperature separation is shown in Figure 3. Briefly, it consists of removing all sulfur compounds and carbon dioxide from the feed gas, after which it is dried to a very low dew point. The hydrocarbon constituents of the stream are then removed in fractions by the progressive lowering of the temperature of the feed stream. The final cleanup of the gas is made by scrubbing out traces of methane and carbon monoxide by means of washing in a column with liquid nitrogen. The nitrogen is supplied by air fractionation.

The scheme in Figure 3 shows the process carried through to the production of ammonia synthesis gas. However, it may be easily adapted to the production of high-purity hydrogen. The gas just before the nitrogen scrub column is 99+ percent hydrogen and may be withdrawn at this point. The 99+ percent hydrogen may be further purified, if desired. The less than one percent of impurity is either methane or a mixture of carbon monoxide and methane when carbon monoxide is present in the feed. These impurities can be reduced to a few parts per million by methanation of the carbon monoxide, fol-

TABLE 2—Operating Requirements for Ammonia Manufacture from Catalytic Reformer Off-Gas
(200-Ton-Per-Operating-Day Plant Capacity)

PROCESSING METHOD	Low-Temperature Separation			Steam Reforming			Partial Oxidation			Reforming with 95 Percent Oxygen			Reforming with Enriched Air			Oil Scrubbing and Steam Reforming		
Feed, percent hydrogen	94.2	85.4	77.7	94.2	85.4	77.7	94.2	85.4	77.7	94.2	85.4	77.7	94.2	85.4	77.7	94.2	85.4	77.7
Raw Materials, Units per Ton of Ammonia:																		
Process gas, per 1,000 std. cu. ft.	74.9	82.5	90.8	57.8	42.8	32.6	59.5	46.7	36.6	58.4	45.6	35.8	62.7	47.3	37.0	57.7	66.1	75.6
a. Fuel gas, million Btu	28.8	41.9	55.6	22.2	21.8	20.0	22.9	23.7	22.4	22.5	23.2	22.0	24.1	24.0	22.7	22.2	33.6	46.3
b. Fuel value, recovered, million Btu	9.8	22.9	36.6	....	....	....	....	....	....	....	....	....	....	....	....	....	11.9	24.7
c. Fuel value to process, million Btu	19.0	19.0	19.0	22.2	21.8	20.0	22.9	23.7	22.4	22.5	23.2	22.0	24.1	24.0	22.7	22.2	21.7	21.7
Monoethanolamine, lb.	0.11	0.12	0.13	0.24	0.29	0.31	0.24	0.31	0.33	0.24	0.32	0.33	0.25	0.33	0.35	0.24	0.25	0.26
Caustic, lb.	2.6	2.6	2.7	3.2	3.3	3.4	8.3	9.7	10.5	7.8	9.3	10.0	4.6	5.9	6.5	3.2	3.2	3.2
Copper scrap, lb.	....	....	....	0.20	0.20	0.20	....	....	....	....	....	....	0.20	0.20	0.20	0.20	0.20	0.20
Formic acid, lb.	....	....	....	0.29	0.29	0.29	....	....	....	....	....	....	0.29	0.29	0.29	0.29	0.29	0.29
Absorber oil, gal.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	8	10
Lubricating oil, gal.	0.45	0.53	0.59	0.50	0.50	0.50	0.57	0.60	0.62	0.55	0.58	0.61	0.46	0.52	0.54	0.53	0.53	0.53
Catalysts, Units per Ton of Ammonia:																		
Reformer, lb.	....	....	....	0.18	0.19	0.20	....	....	....	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Carbon-monoxide, lb.	....	....	....	0.32	0.33	0.34	0.31	0.33	0.34	0.31	0.33	0.34	0.32	0.34	0.35	0.32	0.32	0.32
Ammonia synthesis, lb.	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Utilities, Units per Ton of Ammonia:																		
Fuel gas, million Btu	6.4	7.5	8.4	10.0	10.7	11.5	9.6	10.0	10.1	9.9	10.0	10.3	8.0	8.7	9.0	9.0	9.0	9.0
Steam at:																		
425 psig, lb.	370	370	380	940	1260	1360	2520	3100	3200	2020	3250	3460	990	1380	1510	930	3450	8490
150 psig, lb.	....	....	....	1900	2170	2330	37	62	72	38	63	72	1690	1880	2160	2450	2450	2450
60 psig, lb.	200	200	200	3140	4530	4960	1990	3500	4160	2120	3650	4200	3240	4950	5500	3140	3140	3140
Electric power, kwh	23	24	25	55	55	55	33	34	34	32	33	33	39	55	55	55	62	73
Cooling water, at 85 F., 1,000 gal.	49.6	53.1	55.8	108.6	116.2	119.2	83.6	96.1	99.6	85.4	97.7	102.3	106.1	119.0	123.6	108.6	140.5	198.7
Treated water, gal.	7	8	9	53	92	132	31	70	130	40	73	74	31	66	105	40	40	40
Operators per shift	5	5	5	6	6	6	7	7	7	7	7	7	7	7	7	7	7	7

lowed by absorption of essentially all of the methane on silica gel. With most reformer gases, the carbon-monoxide content in the feed is so low that the methanation step could be omitted.

As shown in Table 2, this process has a great advantage in operating requirements. Per ton of ammonia, low-temperature separation has the lowest consumption for each individual utility of the various recovery processes. It also requires the smallest operating staff. It has the added advantage of returning the hydrocarbon constituents of the off-gas in a more desirable form. A C_5+ cut is available for gasoline blending, and most of the C_3 to C_4 fraction is also recovered as a liquid. The process also can produce oxygen as a byproduct although, for this study, it is produced at low purity and is not credited to the process. The main disadvantage of the process is that it must be designed for a specific feed gas and large variations in feed composition cannot be tolerated.

Steam Reforming: The steam-reforming process is shown schematically in Figure 4. The process is conventional two-step reforming followed by conversion of the carbon monoxide to additional hydrogen. The carbon dioxide is removed by scrubbing with monoethanolamine, and the carbon monoxide by scrubbing with cuprous ammonium formate (copper liquor). Because of the very low carbon content of the off-gas feed, it was thought that the concentration of carbon oxides in the reformed gas might be low enough to permit removal of the carbon monoxide by methanation instead of by the more conventional copper-liquor scrubbing. For the feed with the highest free-hydrogen content, 94.2 percent, the two carbon monoxide removal methods proved to be a standoff costwise. However, for feeds with lower hydrogen content, copper-liquor scrubbing proved to be more economical and was, therefore, used for all three off-gas feeds.

The chief advantages of the steam-reforming process are that it makes available the largest yield of hydrogen per unit of feed gas and can handle a wide variation in feed-gas composition. The main disadvantage is that the process cannot make full use of the high pressure level at which most reformer off-gas is available. In addition, there is but a small saving in equipment cost in the processing of a hydrogen-rich reformer gas as compared to starting with a more conventional feed such as natural gas. Also, as shown in Table 2, steam reforming has the highest consumption of utilities per ton of ammonia produced for the various processes studied.

Partial Oxidation: The partial-oxidation process utilized for producing hydrogen from refiner off-gas is shown schematically in Figure 5. It consists of the preheating of the reformer off-gas after removal of sulfur compounds and the partial oxidization of the off-gas with 95-percent oxygen. The product gas from the combustion step is

Meet the Author

CARL PFEIFFER, who presented this topic, is a process engineer with Catalytic Construction Company, engaged in commercial design and process evaluation for the production of ammonia from refinery byproducts. Holder of B. S. and M. S. degrees in chemical engineering from Pennsylvania State University, his experience includes research work for the Naval Research Laboratory and a more-than-three-year assignment with Houdry Process Corporation.

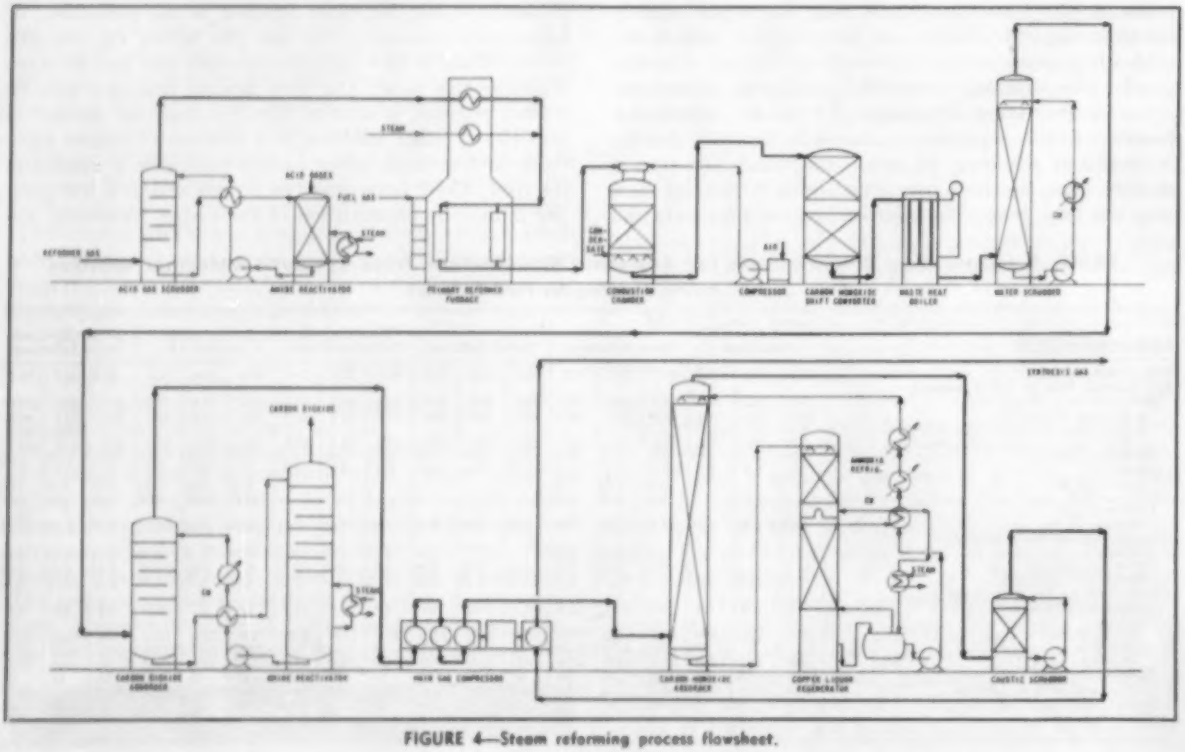

FIGURE 4—Steam reforming process flowsheet.

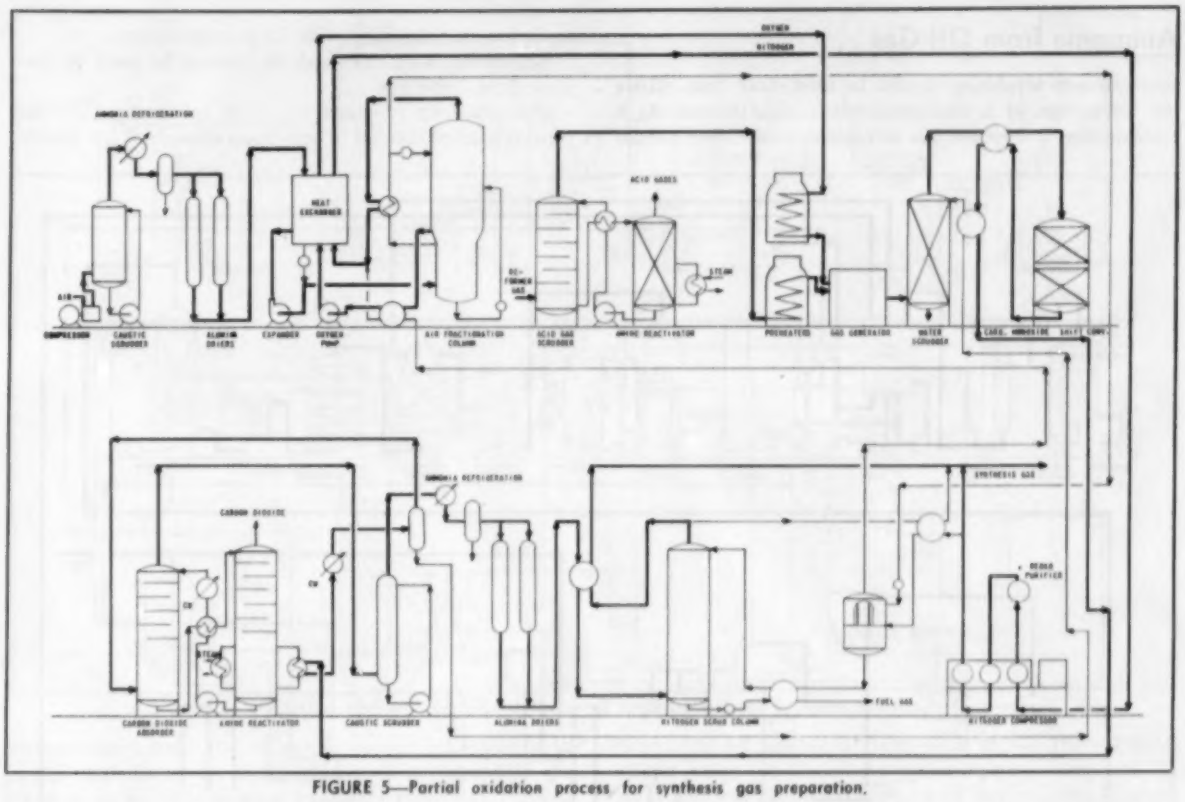

FIGURE 5—Partial oxidation process for synthesis gas preparation.

largely hydrogen and oxides of carbon. This gas is contacted with water, after which it is passed through a shift converter where the carbon monoxide is changed to carbon dioxide and more hydrogen. The carbon dioxide is removed by means of scrubbing with amine and caustic solutions. Final purification is accomplished by washing with liquid nitrogen which is made available by the same air-fractionation plant which produces the 95-percent oxygen.

This process has the advantage of being able to utilize fully the high pressure at which the off-gas is available. It also can handle wide fluctuations in feed-gas composition. However, it shows little advantage in processing the hydrogen-rich off-gases over feeds containing little or no hydrogen.

Reforming with 95-percent oxygen: A typical flow pattern for reforming off-gas with 95 percent oxygen is given in Figure 6. The process is similar to the partial oxidation process, with one main exception. Instead of partial combustion of the off-gas with 95 percent oxygen in an empty chamber at temperatures in the range of 2400 F, the off-gas is reformed in the presence of both steam and 95 percent oxygen over a nickel catalyst at a temperature of 1725 F. The reforming operation is done in a vessel similar to the conventional secondary reformer. The lower temperature allows the use of smaller preheating surfaces and imposes less severe conditions on all combustion equipment than are encountered in partial combustion with oxygen alone. The main advantage of the process, however, is that the requirement for 95-percent oxygen is lower than in simple partial oxidation. In the case of most reformer off-gases this results in oxygen and nitrogen requirements which are very nearly in balance with the ratio in which they are produced by air fractionation. In standard partial-oxidation processes a large surplus of nitrogen is usually produced to satisfy the oxygen requirement. Reforming with 95-percent oxygen shares with the partial-oxidation method the ability to take full advantage of the high pressure level of the feed gas and can handle a wide variety of feeds.

Reforming with enriched air: The production of hydrogen by means of reforming off-gas with enriched air is presented in Figure 7. It consists of removing the sulfur compounds from the feed gas and reforming with steam and with just enough air enriched with 95-percent oxygen to produce the correct 3:1 hydrogen-to-nitrogen ratio in the synthesis gas after reforming and carbon-monoxide conversion is completed. After the carbon-monoxide shift the gas is quenched and the carbon dioxide is removed by means of amine scrubbing. Final cleanup of the gas cannot be done by nitrogen scrubbing because of the high nitrogen content of the gas. Thus the nitrogen produced by the air-separation plant which supplies the oxygen for air enrichment cannot be utilized. This presents the major disadvantage of the process. Conventional copper-liquor scrubbing is used instead of a nitrogen wash.

The process requires a smaller air plant than the previously described process in which the reforming was done with 95-percent oxygen instead of minimum-oxygen-content enriched air. However, because of the additional nitrogen gas carried through the reforming step, more preheating is required for the feed materials. The fact

that nitrogen scrubbing cannot be used more than offsets the advantage of a smaller-air-plant requirement. As a consequence it appears less attractive than either partial oxidation or reforming with 95 percent oxygen.

Reforming with enriched air cannot be used to produce pure hydrogen.

Oil scrubbing followed by steam reforming: The last process studied consists of scrubbing enough of the heavier

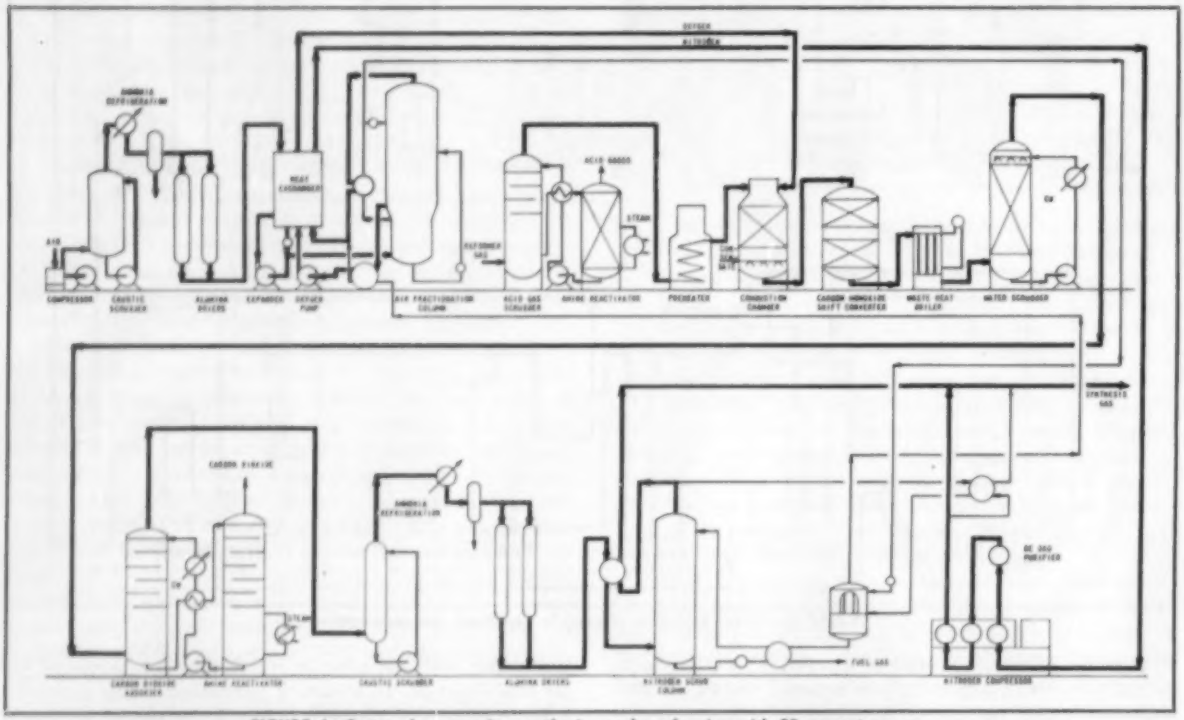

FIGURE 6—System for preparing synthesis gas by reforming with 95 percent oxygen.

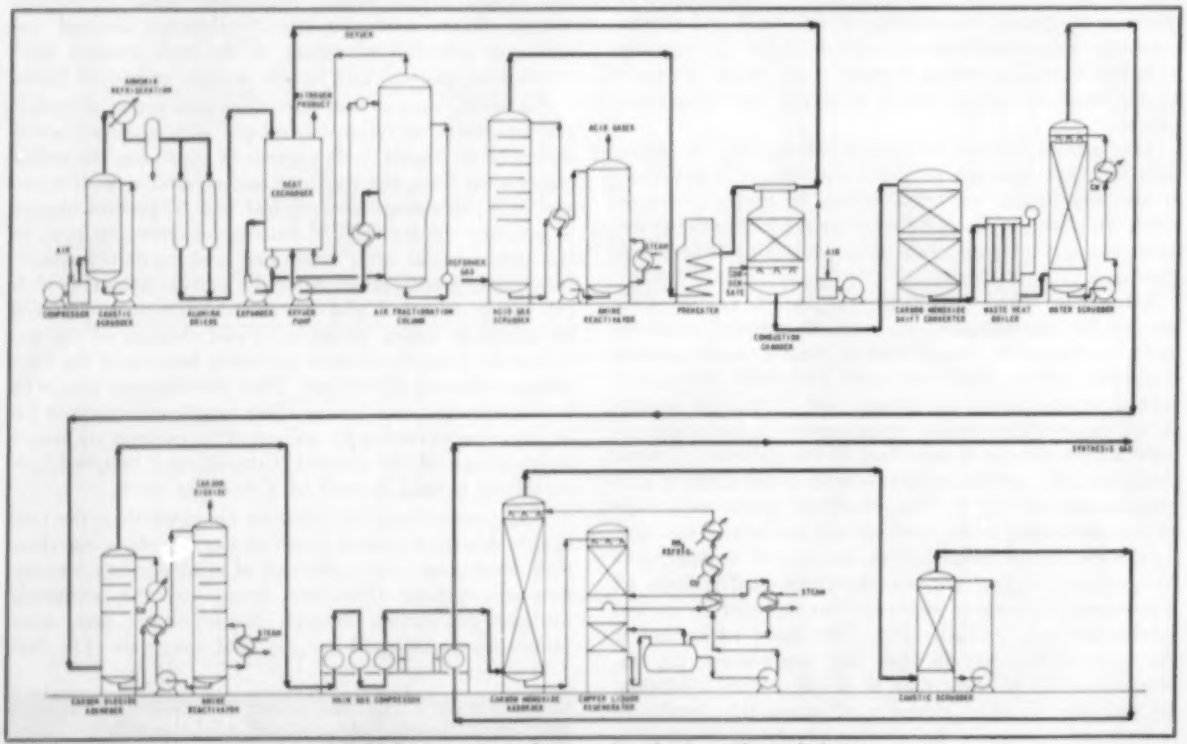

FIGURE 7—Ammonia synthesis gas by reforming with enriched air.

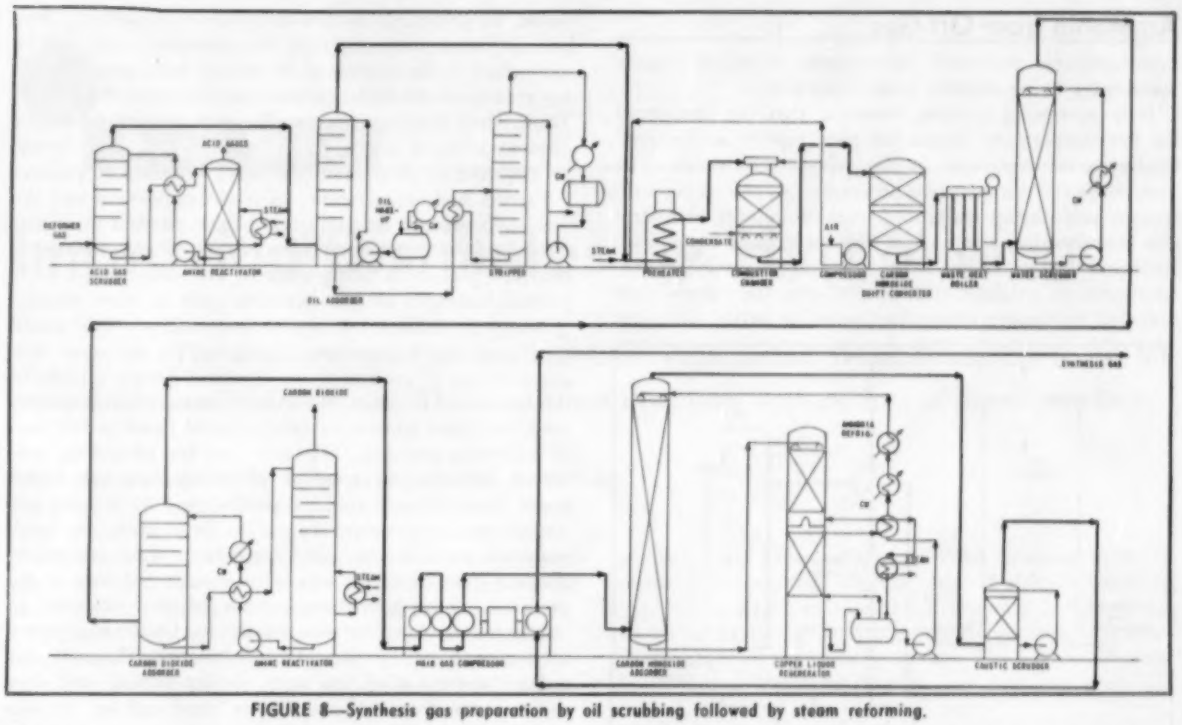

FIGURE 8—Synthesis gas preparation by oil scrubbing followed by steam reforming.

hydrocarbons from the off-gas to permit reforming with steam and air in an operation which is essentially the same as in the conventional secondary reformer. The object of the scheme is to eliminate the expensive primary reformer or the need for oxygen-producing equipment. The process scheme studied is shown in Figure 8. After sulfur is removed from the feed gas, most of the heavier hydrocarbons are taken out by absorption in an oil scrubber. These hydrocarbons are recovered in a stripping operation. The off-gas is reformed with air and steam after scrubbing. The remainder of the process is similar to that described for conventional steam reforming.

A study of the three feed streams revealed that the 94.2-percent hydrogen steam can be reformed directly with air, without any hydrocarbon removal, if both the air and steam to the reformer are preheated sufficiently. The two streams with higher hydrocarbon content must be scrubbed. The 94.2-percent feed contains nearly the maximum amount of hydrocarbons which can be tolerated in a reforming operation with unenriched air. For this reason the oil-absorption operations for the two higher hydrocarbons feeds are designed to produce scrubbed gases with a hydrocarbon content equivalent to the 94.2-percent feed. Reduction of the hydrocarbon content to this level was calculated as the minimum scrub which can be tolerated; however, even this reduction necessitates expensive scrubbing operations. In order to use air for the reforming step, it is necessary to give the feed streams the maximum amount of preheating and also to reduce the amount of reforming steam to a minimum. Reduction of the amount of reforming steam makes it necessary to carry out the reforming at a maximum pressure of 105 psia in order to produce a tolerable amount of residual hydrocarbon in the reformed gas. Thus the high pressure level at which the off-gas is available cannot be completely utilized.

Economic Analysis—A plant design was made for the production of ammonia from each of the three typical off-gas feeds for all six hydrogen-recovery processes. A plant cost was estimated for each of the resulting 18 plant designs. These costs are given in Table 3. The plant cost estimates are for battery-limits plants and include all utility piping, roads, railroad sidings, storm sewers, track scales, and the other items normally included within the battery limits. Off-site facilities, such as office buildings, maintenance shops, cooling towers, or steam plant, are not included in the estimated capital costs. However, these items are taken into account in the economic study by means of using unit costs which include the write-off of the capital investment required for them. All compressors have been estimated for the gas engine drive. Each plant includes ten days' storage of ammonia in the form of two refrigerated hortonspheres.

The operating requirements for each plant, as tabulated in Table 2, and the plant cost estimate already discussed were used in order to prepare an operating cost estimate for each of the 18 cases. The results are summarized in Table 3. The typical unit costs used for each cost item are also presented in Table 3. The final cost in dollars per ton of ammonia produced vs. free-hydrogen concentration in the feed gas is plotted in Figure 2 as a function of each of the hydrogen-recovery methods. This plot best summarizes the entire study. It shows that a design utilizing low-temperature separation to produce the synthesis gas is the most economical process for any catalytic reformer off-gas in the composition range which has been studied when sufficient hydrogen is available to produce 200 tons of ammonia per day. Reforming with 95-percent oxygen and partial oxidation are the next two

most desirable processes, the oxygen reforming process apparently being slightly more favorable.

It is interesting to note, however, that the cost curve for low-temperature separation rises rapidly as the concentration of hydrogen in the off-gas goes down. The cost curve for the next two processes, i.e., reforming with oxygen and partial oxidation, level off rapidly as hydrogen concentration drops. It is evident that, at some free-hydrogen concentration below the range ordinarily encountered in catalytic reformer off-gas, the curves cross and that the oxygen reforming process or partial oxidation would be preferable to low-temperature separation. Preliminary work indicates that the crossover point will be somewhere in the vicinity of 50-percent hydrogen, depending greatly on the hydrocarbon constituents of the off-gas. Thus, when dealing with an off-gas of this free-hydrogen concentration or lower, e.g., coke-oven gas, study would be required to determine the most economical process.

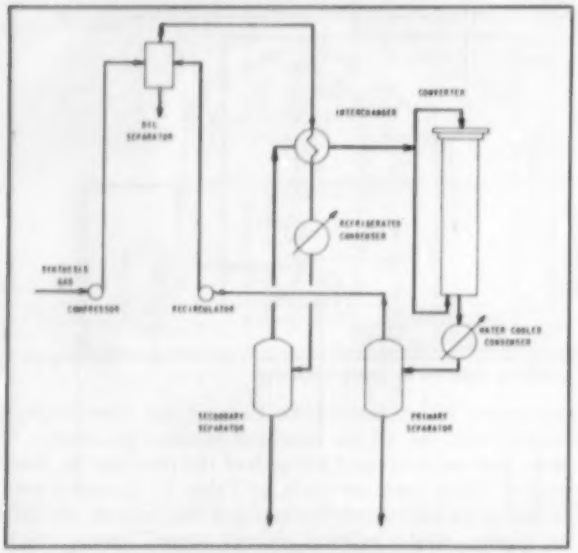

FIGURE 9—Typical ammonia-synthesis unit used with any of the six synthesis gas preparation processes.

Factors such as reliability of feed composition and the yield of hydrogen desired from a fixed amount of off-gas should also be given some consideration when a hydrogen-recovery process is being chosen. For example, a 77.7-percent-hydrogen off-gas available only in large enough quantity to produce 50 tons of ammonia per day would show that low-temperature separation is the most economical way of producing the synthesis gas for a plant of this particular tonnage. However, if steam reforming were used, the same amount of off-gas could produce 140 tons of ammonia per day. The unit cost for producing ammonia with the larger steam-reforming plant may prove lower than the unit cost for producing only 50 tons per day by low-temperature separation. In addition, any large variation in unit operating costs from those shown in Table 3 may effect the relative economic positions of the processes which have been considered. For example, in any particular case low-temperature separation may prove most economical for the initial installation. However, for a later expansion of the same facility partial oxidation utilizing the byproduct oxygen produced by the air-separation plant in the original installation would probably prove to be the most economical process.

Original presentation was at the midyear meeting, API Division of Refining, St. Louis, May 11, 1955.

ACKNOWLEDGMENT

The authors wish to acknowledge the assistance given them by: Texaco Development Corporation, New York, in supplying yield and cost data on the partial-oxidation process; Air Products, Inc., Allentown, Pa., for cost and process data on the low-temperature equipment included; and the Haldor Topso organization of Hellerup, Denmark, for data used in various sections of the discussion.

TABLE 3—Operating Costs for Ammonia Manufacture from Catalytic Reformer Off-Gas
(Costs in Dollars Per Ton of Ammonia for 200-Ton-Per-Day Plant)

Processing Method	Low-Temperature Separation			Steam Reforming			Partial Oxidation			Reforming with 95 Percent Oxygen			Reforming with Enriched Air			Oil Scrubbing and Steam Reforming		
Feed, percent hydrogen	94.2	85.4	77.7	94.2	85.4	77.7	94.2	85.4	77.7	94.2	85.4	77.7	94.2	85.4	77.7	94.2	85.4	77.7
Investment in thousands of dollars	4,677	4,973	5,259	5,552	5,648	5,708	5,186	5,362	5,457	5,025	5,207	5,324	5,499	5,706	5,783	5,486	6,145	6,297
Raw Materials Costs:																		
Process gas, at $0.30 per million Btu	5.70	5.70	5.70	6.68	6.53	5.98	6.87	7.11	6.72	6.73	6.95	6.59	7.23	7.21	6.81	6.66	6.52	6.50
Monoethanolamine, at $0.27 per lb.	0.03	0.03	0.04	0.06	0.08	0.08	0.06	0.08	0.09	0.06	0.08	0.08	0.07	0.09	0.09	0.06	0.07	0.07
Caustic at $0.04 per lb.	0.10	0.11	0.11	0.13	0.13	0.14	0.33	0.39	0.42	0.31	0.37	0.40	0.18	0.24	0.26	0.13	0.13	0.13
Copper scrap, at $0.30 per lb.	....	....	....	0.06	0.06	0.06	....	....	....	....	....	....	0.06	0.06	0.06	0.06	0.06	0.06
Formic acid, at $0.17 per lb.	....	....	....	0.05	0.05	0.05	....	....	....	....	....	....	0.05	0.05	0.05	0.05	0.05	0.05
Absorber oil, at $0.79 per gallon	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1.52	1.90	
Lubricating oil, at $0.80 per gallon	0.36	0.42	0.49	0.40	0.40	0.40	0.46	0.48	0.49	0.45	0.46	0.48	0.37	0.41	0.43	0.42	0.42	0.42
Reformer catalyst, at $1.28 per lb.	....	....	....	0.23	0.24	0.26	....	....	....	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Carbon-monoxide shift catalyst, at $0.70 per lb.	....	....	....	0.22	0.23	0.24	0.22	0.23	0.24	0.22	0.23	0.24	0.22	0.24	0.25	0.22	0.22	0.22
Ammonia synthesis catalyst, at $0.51 per lb.	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Total	6.24	6.31	6.39	7.88	7.76	7.26	7.99	8.34	8.01	8.02	8.34	8.04	8.43	8.55	8.20	7.85	9.24	9.60
Direct Production Costs:																		
Personnel:																		
Labor:																		
Operators, at $2.50 per hour	1.46	1.46	1.46	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78
Helpers, at $2.00 per hour	0.32	0.32	0.32	0.32	0.32	0.32	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
Supervision, at $7,000 per year	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
Payroll overhead, at 15 percent labor and supervision	0.33	0.33	0.33	0.38	0.38	0.38	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
Maintenance, at 4 percent plant investment per year	2.72	2.88	3.05	3.22	3.27	3.30	3.10	3.10	3.16	2.91	3.02	3.09	3.19	3.31	3.76	3.18	3.56	3.65
Equipment supplies, at 0.25 percent plant investment per year	0.17	0.18	0.19	0.20	0.20	0.21	0.19	0.19	0.20	0.18	0.19	0.19	0.20	0.21	0.21	0.20	0.22	0.23
Utilities:																		
Fuel gas, at $0.30 per million Btu	1.91	2.24	2.51	3.01	3.21	3.45	2.87	3.00	3.02	2.96	3.01	3.10	2.40	2.61	2.66	2.69	2.69	2.69
Electric power, at $0.009 per kwh	0.20	0.21	0.22	0.49	0.49	0.49	0.30	0.30	0.31	0.29	0.30	0.30	0.35	0.49	0.50	0.50	0.55	0.66
Cooling water, at $0.02 per 1,000 gallons	0.99	1.06	1.12	2.17	2.32	2.38	1.67	1.92	1.99	1.71	1.95	2.05	2.12	2.38	2.47	2.17	2.81	3.98
Steam, at $0.55 per 1,000 lb.	0.31	0.31	0.32	3.32	4.38	4.76	2.48	3.67	4.09	2.63	3.83	4.25	3.33	4.52	5.04	3.38	4.98	7.75
Treated water, at $0.18 per 1,000 gallons	0.00	0.00	0.00	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01
Total	8.83	9.43	9.96	15.34	16.81	17.53	13.75	15.41	16.01	13.91	15.53	16.21	14.82	16.75	17.48	15.55	18.04	22.19
Indirect Production Costs, at 55 percent Labor, Supervision, and Maintenance	2.72	2.81	2.95	3.22	3.25	3.27	3.25	3.30	3.34	3.19	3.26	3.30	3.38	3.36	3.39	3.29	3.49	3.55
Fixed Costs:																		
Depreciation, at 10 percent plant investment per year	6.77	7.21	7.62	8.05	8.18	8.26	7.52	7.76	8.05	7.28	7.54	7.72	7.96	8.26	8.38	7.96	8.89	9.13
Taxes, at 1 percent plant investment per year	0.68	0.72	0.76	0.81	0.82	0.83	0.75	0.78	0.81	0.73	0.75	0.77	0.80	0.83	0.84	0.80	0.89	0.91
Insurance, at 1 percent plant investment per year	0.68	0.72	0.76	0.81	0.82	0.83	0.75	0.78	0.81	0.73	0.75	0.77	0.80	0.83	0.84	0.80	0.89	0.91
Total	8.13	8.65	9.14	9.67	9.82	9.92	9.02	9.32	9.67	8.74	9.04	9.26	9.56	9.92	10.06	9.56	10.67	10.95
Total Manufacturing Cost	25.94	27.20	28.44	36.11	37.64	37.98	34.01	36.37	37.03	33.86	36.17	36.81	36.11	38.58	39.13	36.25	41.44	46.29

Process Session

Improving Distillates by Hydrofining

The hydrofining of a distillate from high-sulfur West Texas crude oil improved its quality to that of Mid-Continent distillate, with no loss of liquid product.

W. J. Zimmerschied, R. A. Hunt, Jr., and W. A. Wilson,
Standard Oil Company (Indiana), Whiting

DISTILLATE FUELS produced from certain crude oils cannot be finished by conventional methods so as to make products which are competitive on the present market. They may have high sulfur or nitrogen contents, contain greater-than-usual concentrations of aromatics, or have offensive odors. All these properties adversely affect quality, and unusually severe refining is needed to eliminate them.

A distillate from West Texas high-sulfur crude oils is a good example of such a product. Its high mercaptan content makes it difficult to sweeten by conventional techniques, such as copper chloride or doctor sweetening. Even the sweet product has a bad odor, high sulfur content, and poor burning quality. The odor is due to cyclic sulfides;[1] the poor burning quality, to the high aromatics content.

Processes which have been used successfully for such distillates include acid treating and solvent extraction. Mild acid treating markedly reduces the mercaptan content, but it has little effect on the odor, sulfur content, or burning quality. Acid treatment severe enough to improve all the properties results in excessive loss of product. Solvent extraction, e.g., with sulfur dioxide, produces a fuel of acceptable quality but, again, with excessive loss.

Studies in our laboratories suggested that a high-quality product could be made from a West Texas distillate by means of hydrofining. Thorough desulfurization would be expected to solve the odor and sweetening problems, and the hydrogenation of aromatics—particularly polycyclics—should improve the burning quality. The high yields associated with hydrofining made this method especially attractive.

Whereas previous studies of hydrofining have been aimed mainly at desulfurization,[2,7,8] our objective was both desulfurization and the improvement of the burning quality. Because the usual inspection tests on fuels do not reflect burning quality under conditions of normal use, hydrogen content and smoke point were determined and full-scale burning tests were made in this study.

Experimental—The hydrofining studies were carried out in the flow reactor shown schematically in Figure 1. The feed was a No. 1 fuel oil (ASTM D 396-48T) from West Texas crude oils high in sulfur and aromatics content. The small amount of naphtha formed during hydrofining was stripped under an inert atmosphere so as to give fuel oils with a flash point of 120 F. Operating conditions for hydrofining varied over a wide range:

Temperature	550 to 850 F.
Pressure	500 to 3,000 psi.
Space velocity	1 to 15 volumes per volume per hour.
Hydrogen	500 to 3,000 scf per barrel of feed.

Severity of operation, judged by the increase in hydrogen content, generally depended upon the operating conditions but also varied with the catalyst. Commercial hydrogenation catalysts were used; the choice depended upon the desired quality of the product.

The quality of the raw and hydrofined distillates was determined by inspection tests, measurement of hydrogen content, and burning-quality tests. The inspection tests were conventional—ASTM distillation, API gravity, flash point, pour point, color, sulfur content, and doctor test. Hydrogen content of the liquids was measured conveniently and rapidly by beta-ray absorption.[6] This technique gave a direct measure of hydrogen consumption during hydrofining, a measurement which had previously been difficult with laboratory units. The burning quality

Meet the Author

W. J. ZIMMERSCHIED presented the accompanying article to a session on processes during the Division of Refining's meeting in St. Louis, Mo. He is co-author with R. A. Hunt, Jr., and W. A. Wilson. All three are connected with Standard Oil Company (Indiana) at Whiting, Ind.

Dr. Zimmerschied received his bachelor's degree from Monmouth College, and took both his master's and doctor's degrees from Ohio State University. He joined the Standard organization in the Research department in 1945. He since has worked on various hydrocarbon and separation processes.

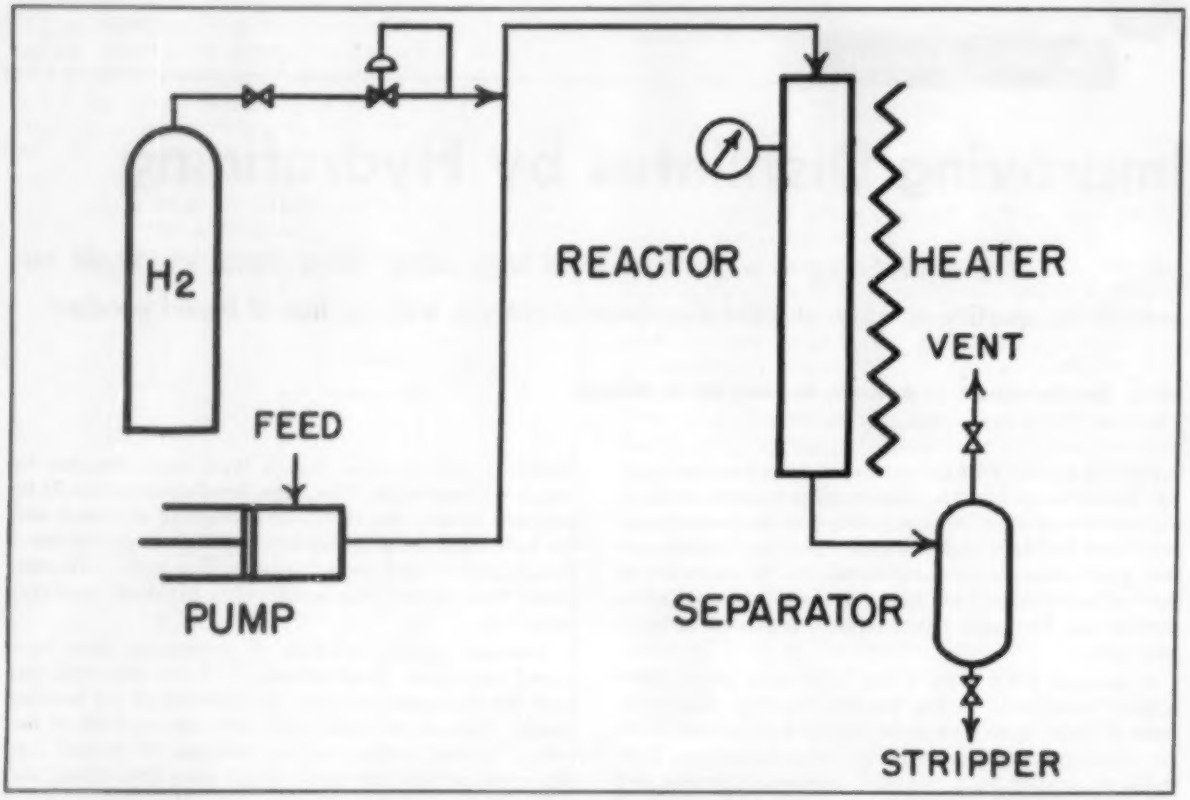

FIGURE 1—High-pressure flow reactor: Studies were made on this unit.

was measured by smoke point and by a full-scale burner test.

The smoke point is the height, in millimeters, of a wick-fed flame in a standard lamp under conditions of incipient smoking.[5] Smoke points were determined with the Factor lamp, modified so as to improve accuracy.[9]

Full-scale burner tests were carried out in a modified pot-type burner under standard operating conditions.[10] Two and one-half gallons of the fuel were burned in 20 hours. The burner was then taken apart, and side and bottom deposits were removed separately from the pot section and weighed. Side deposits give a measure of the sooting tendency of the fuel, and have been correlated with the smoke point;[10] the higher the smoke point, the less the sooting tendency. Bottom deposits have not been successfully correlated with the properties of the fuel; they are caused by nonvolatile impurities which are inherent in the crude oil, form during treating, or result from oxidation or other chemical reactions which accompany burning.

Effect of Hydrofining on Fuel Quality—Hydrofining was found to eliminate the bad odor, reduce the sulfur content, and improve the burning quality of West Texas No. 1 fuel oil. The effects of hydrofining are shown in Table 1. Corresponding data for the raw West Texas distillate, for a mildly acid-treated West Texas distillate, and for a good-quality No. 1 fuel from Mid Continent crude oil are also shown.

TABLE 1
Inspection of Distillates

	WEST TEXAS				
		Hydrofined		Mildly Acid-Treated	Mid Continent Sweetened
	Raw	Mild	Severe		
Gravity, deg. API	41	42	44	41	42
Pour Point, F.	−60	−60	−60	−60	−45
ASTM distillation, F.:					
Initial boiling point	325	320	316	325	320
End point	547	545	533	549	550
Color, Saybolt	16	27	30	15	17
Aged color*	5	13	30	3	9
Aromatics, percent by volume	20	16	9	....	15
Sulfur, percent by weight	0.6	0.02	0.01	0.6	0.2
Doctor test	Sour	Sweet	Sweet	Sour	Sweet
Mercaptan number†	60	0	0	.40	0
Odor	Bad	Good	Good	Bad	Good

* After 1 hour at 290 F.
† Milligrams mercaptan sulfur per 100 ml.

Desulfurization was thorough under both mild and severe hydrofining conditions; the original sulfur content of 0.6 percent was reduced to 0.02 percent or less. The products were doctor sweet and required no further finishing. The odor of the hydrofined products was improved to approximately that of a No. 1 fuel oil from Mid Continent crude oil. The color before and after accelerated aging improved markedly. Even mild hydrofining conditions gave a product of lighter aged color than Mid Continent fuel oil.

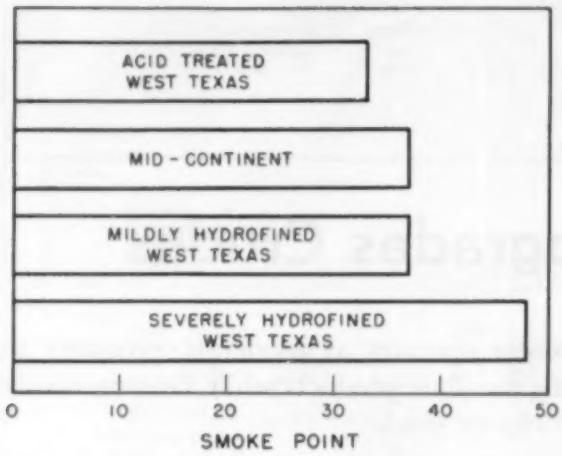

FIGURE 2—Smoke point of distillates: As good as Mid-Continent.

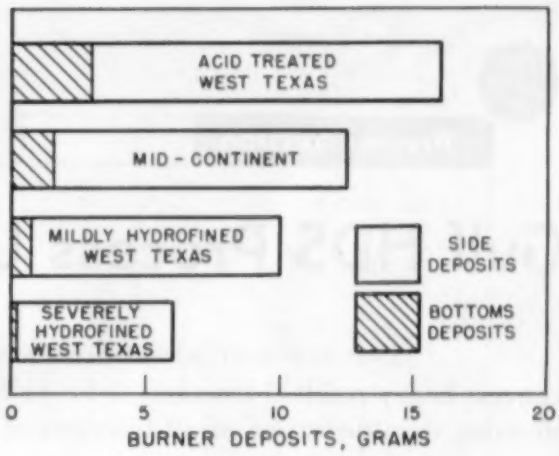

FIGURE 3—Burner deposits from distillates.

Smoke points of the hydrofined products are compared, in Figure 2, with those for a mildly acid-treated West Texas distillate and a Mid Continent fuel oil. Under mild conditions the smoke point of the West Texas distillate was increased from 33 to 37, equal to that of the Mid Continent fuel. Severe hydrofining boosted the smoke point to 48.

Results from full-scale burner tests are shown in Figure 3. Mild conditions lowered total burner deposits from 16 g to 10 g, as compared with 13 g for Mid Continent fuel oil. Severe hydrofining lowered total burner deposits to 6 g. Both side and bottom deposits were reduced.

Aromatic hydrocarbons have low smoke points and give large amounts of burner deposits.[4,10] Raw West Texas distillate contains 20 percent aromatics. Mildly hydrofined West Texas distillate and Mid Continent fuel oil contain approximately 15 percent aromatics. Severe hydrofining reduces total aromatics content to 9 percent—naphthalenes content was reduced from 4 percent to less than 1 percent in this instance.

Hydrogen contents of the fuel oils are plotted against the smoke points in Figure 4. A straight-line correlation was found for smoke points between 28 and 48 and hydrogen contents between 13.5 percent and 14.3 percent.

Mild hydrofining thus gives a product equivalent in quality to a Mid Continent fuel oil, and severe hydrofining produces a superior fuel oil.

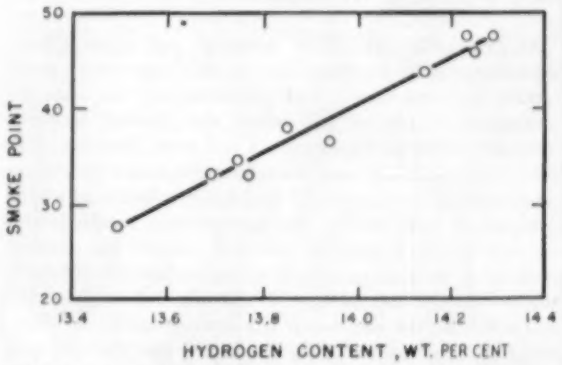

FIGURE 4—Correlation of smoke point with hydrogen content: A straight-line function.

Conclusion—Hydrogen consumption during hydrofining was calculated from the hydrogen content of the feed and the products. Consumption of 90 scf per barrel of feed increased the smoke point from 33 to 37; consumption of 300 scf increased it to approximately 48.

The yields of total liquid product—fuel oil and naphtha—were between 100 and 101 volume percent, naphtha being about 4 percent of the total. Hydrofining, therefore, gives a higher yield than other refining processes, such as acid treating or solvent extraction.

The by-product naphtha produced during hydrofining was an excellent feed for catalytic reforming. Under Ultraforming conditions[3] a product with a Research octane number of 95, clear, was produced in high yields.

The quality improvement obtained by hydrofining the West Texas distillate is typical of that possible with other distillates. With byproduct hydrogen available from catalytic reforming units, refiners can easily improve marginal or inferior fuel-oil components to high-quality products.

Original presentation was before the API Division of Refining, St. Louis, May 11, 1955.

ACKNOWLEDGMENT

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API Process Session

Process Session

Gulf HDS Process Upgrades Crudes

This new hydrodesulfurization process operates at moderate pressures to convert heavy residual fractions to lower-boiling distillate products while simultaneously effecting desulfurization of all fractions of the charge stock.

Jerry McAfee, C. W. Montgomery, J. N. Hirsch, W. A. Horne and C. R. Summers, Jr.

ALTHOUGH SULFUR removal and other quality improvements in distillates are of real importance under certain circumstances, hydrogenation of the heaviest portions of crude oil still offers the greatest incentive from an economic standpoint. Until now, however, relatively high pressure and, therefore, expensive processing methods have been required to achieve substantial hydrogenation of such stocks. This presentation results from a ten-year research program directed toward the development of a reduced-cost hydrogenation process especially adapted to the upgrading of crude oils and residues. It is believed that the day when the hydrogenation of heavy stocks will be economically attractive has thereby been brought considerably nearer. (Several processes for hydrodesulfurization of *distillate* stocks have been described in the recent literature[1, 2, 3, 4] and some are reported to be in commercial operation[5]).

Laboratory Work—Initial laboratory work beginning in 1943 was aimed at testing the desulfurization activity of a wide variety of materials with the use of heptane-thiophene mixtures. As a result of this work it was concluded that compositions of nickel oxide supported on alumina, silica, or silica-alumina were most active for desulfurization. Upon application of these materials to various distillates, including West Texas straight-run gasoline and gas oil, it was determined that moderate hydrogen circulation, even at relatively low pressures, was of considerable benefit in reducing coke deposition. Suitably stable nickel-oxide compositions were developed which successfully withstood repeated flue gas-air or steam-air regeneration. These initial studies indicated that through the use of unreduced nickel oxide, it was possible to desulfurize cracked gasoline rather completely without the simultaneous reduction of the bromine and octane numbers. In the course of this early work on distillate stocks the processing of total West Texas crude oil was attempted. It was found that not only where the various fractions of the crude oil desulfurized to a considerable degree, but at the same time much of the heaviest portion of the crude was converted into lower-boiling materials, without excessive coke deposition. This discovery had a profound influence on the subsequent course of the development because it provided a clue as to how hydrodesulfurization might be made economically self-sustaining instead of simply constituting a treating expense imposed by product quality requirements.

Accordingly, an intensive search was begun for improved catalysts which would more effectively combine the hydrocracking and hydrodesulfurization functions. The objective was to develop catalysts possessing high activity at moderate pressures and sufficient stability to be used in a cyclic regenerative process. It was felt that a moderate-pressure regenerative process would show a considerable advantage over the high-pressure, nonregenerative techniques which had previously been employed for heavy oils. After extensive research, compound supported metallic catalysts were developed which were shown to have considerably improved hydrocracking activity compared with the previously used nickel oxide. These catalysts were used satisfactorily in extended experimental programs on numerous total crude oils and residual stocks.

Pilot-Plant Work—By 1946 the laboratory investigation had progressed to such a point that a decision was made to continue the development in a large-scale pilot plant in order to establish more firmly the economic attractiveness of the process. After careful consideration of the chemical-engineering objectives of the pilot plant, it was concluded that it would be more desirable to build the unit large enough to utilize small-size commercial equipment rather than large-size laboratory equipment. Accordingly, a pilot plant with 50-barrel-per-day nominal capacity was authorized, designed, and constructed at Gulf Oil Corporation's Port Arthur refinery. This plant was operated continuously for over five years, during which time the process was proved to be completely feasible from an engineering and operating standpoint. Simultaneously the data from the laboratory units, including a plant of approximately 0.5 bbl. per day which was built for charge-stock evaluations and additional development studies, were correlated with those from the 50-barrel-

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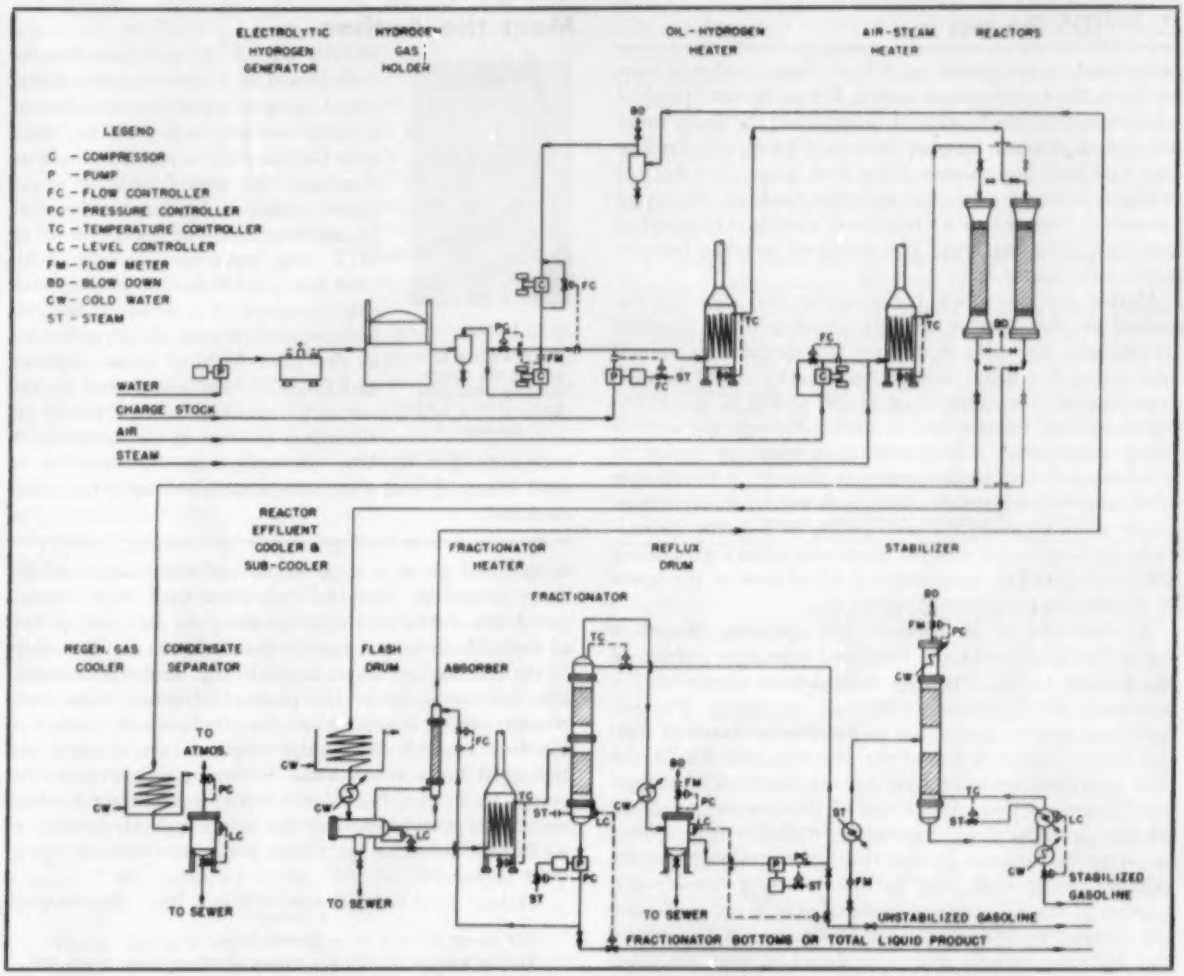

FIGURE 1—Flow diagram of 50-barrel-per-day pilot plant: Operated continuously for more than five years.

per-day pilot plant so that the results obtained on each could be interrelated.

1. *Description of pilot plant*—Figure 1 is a simplified flow diagram of the 50-barrel-per-day pilot plant, description of which may be divided into hydrogen-oil feed, reaction, product separation, and regeneration sections.

For operating convenience, hydrogen is prepared in an electrolytic generator having a rated capacity of 25,000 scf per day. A three-stage fresh-hydrogen compressor takes suction on a 4000-cubic-foot gas holder and pumps hydrogen to the reactor system as required to maintain a constant reaction pressure. The charge stock is pumped from storage by means of a reciprocating duplex plunger pump, the rate being controlled by means of a flow controller on the pump outlet which regulates the steam to the pump. The oil and hydrogen are heated to reaction temperature either separately or together in either of two cylindrical, radiant furnaces (only one of which is shown in Figure 1) rated at 1,500,000 and 500,000 Btu per hour and containing Type 316 stainless-steel tubes.

The preheated oil-hydrogen steam enters one of the two reactors. These vessels have a 14½-inch id, a 0.75-inch wall thickness, and are 13½ feet long, with a 3⅜-inch-thick ring-type flange closure on each end. A 10-foot catalyst bed is supported by a perforated plate covered with a 3-inch layer of ¼-inch alumina balls. A similar layer of alumina balls is also placed on top of the bed. Temperatures are measured by means of 10 thermocouples placed at 1-foot intervals in a ¼-inch-id thermowell extending lengthwise through the catalyst bed. The reactors are so manifolded that one can be used for processing while the other is undergoing regeneration. Both reactors and their switch valves are enclosed in a reinforced concrete stall.

The reactor effluent passes through a submerged cooler, a double-pipe subcooler, and a high-pressure flash drum in which gas, oil, and water are separated. The flashed gas passes to an absorber designed to scrub the heavier components from the recycle gas. A single-stage recycle compressor circulates a predetermined amount of the hydrogen-rich gas back to the inlet of the preheating furnace. The recycle flow rate is controlled by a spill-back valve from the discharge to the suction of the compressor. The hydrogen content of the recycle gas is controlled by the flow of lean oil to the absorber or by the bleeding off of a portion of the recycle gas from the system. Water from catalyst reduction, and to a lesser extent from the oil charge itself, is withdrawn to a weigh drum by means of a liquid-level controller. The hydrocarbon phase, which is mixed with rich absorption oil when the absorber is

being used, is withdrawn by a level-control valve to storage or to the fractionation system. For continuous product separation the condensed oil flows from the flash drum through a radiant furnace into an 18-inch-od, raschig-ring—packed fractionator 32½ feet long. The bottom product is pumped to the absorber, and the overhead product is pumped to a 16-inch-od raschig-ring—packed stabilizer 26½ feet long. The stabilized gasoline bottoms product flows to storage.

During the processing period sulfur and coke are deposited on the catalyst so that regeneration is required periodically. In order to remove this deposit, air diluted with either live steam or a recirculated stream of flue gas is preheated to a temperature of 750 to 850 F. in a cylindrical radiant furnace and is passed through the reactor being regenerated. The regeneration gases are cooled in a submerged coil cooler and pass through a condensate separator. The noncondensible gas is vented to the atmosphere when regenerating with steam, or is partly recirculated by the flue-gas recycle compressor when regenerating with flue gas. The condensate is withdrawn to the sewer by means of a level-control valve.

2. *Operation of pilot plant*—The operating procedure for a typical cycle of the fixed-bed downflow version of the process (which has been studied most extensively) is presented as illustrative of normal operation. The oil-hydrogen stream, preheated to the desired reaction temperature, is cut into one of the reactors, and the process flow continues uninterrupted for the duration of the desired process period. At the end of the process period the oil flow is stopped and hydrogen circulation is continued to purge the reactor. During this hydrogen-purge period, usually lasting from one to two hours, a considerable portion of the oily carbonaceous deposit is removed from the catalyst by hydrogenation. At the end of this period the hydrogen-recycle stream is switched into the other reactor which, by then, has been regenerated. The first reactor is depressured into the blowdown system and is purged for 10 minutes with superheated steam. The reactor effluent is then cut into the regeneration-gas cooler, and air is added to the regeneration steam or recirculated flue gas as rapidly as is possible without exceeding a catalyst temperature of 1200 F. The use of steam as the regeneration diluent has been found to be more convenient from an operating standpoint and has been used almost exclusively. The air-to-steam ratio is maintained as high as consistent with the avoidance of localized overheating of the catalyst bed and reactor. While holding a constant reactor inlet temperature of 750 to 850 F., and a constant steam rate and air-to-steam ratio, the regeneration is continued until the temperature at the outlet of the bed declines to 1050 or 1100 F. At this time the regeneration-air flow is stopped, and the regeneration steam is allowed to continue flowing for an additional five minutes in order to purge the reactor. The regeneration steam is then bypassed around the reactor, and the reactor is blocked off until the processing period on the other reactor has been completed. Just before switching, the reactor is brought to operating pressure by means of recycle gas. The recycle stream is then cut through the catalyst bed, and immediately thereafter oil flow is resumed, thus completing the cycle.

Process Modifications—Both in bench-scale units and in the pilot plant, a large number of modifications of the basic downflow, fixed-bed operation have been investigated. For example, simply reversing the direction of flow of the oil-hydrogen stream so that it enters at the bottom of the reactor and leaves from the top results in considerable improvement in the product obtained from some charge stocks, inasmuch as the unvaporized portion of the feed is subjected to the action of the catalyst and hydrogen for a longer time. However, this arrangement results in an accumulation of liquid in the reactor which must be removed during the purge period, leading to additional handling problems and sometimes to higher coke deposition.

Various fluid catalyst modifications have also received

Meet the Author

McAfee

Dr. McAfee presented the accompanying discusion before the API session.

JERRY McAFEE, vice president of Gulf Research & Development Company, has a broad background in upgrading crudes and residues, both with Gulf and Universal Oil Products Company. He joined UOP as a research chemical engineer in 1940, following completion of his doctorate at MIT, and became associated with Gulf five years later. He started with that company as a technical specialist in charge of pilot-plant operations at the Port Arthur, Texas, refinery and in 1950, was transferred to the research company as director of its Chemical division in Philadelphia. A year later, Dr. McAfee was named assistant director of Gulf Research and since then, has moved up to associate director.

TABLE 1

Typical Results of HDS Processing of West Texas Crude Oil

Yields, Percent by Weight on Charge:	
Dry Gas	2.78
Depropanized liquid product	94.51
Catalyst carbon	1.67
Sulfur removed	1.33
Total	100.29
Hydrogen consumption, scf per bbl. on charge	426

	Crude Charge	HDS Product
Data on Charge and Total Liquid Product:		
Yield, percent by volume	....	99.8
Desulfurization, percent	....	85.1
Inspections:		
Gravity, deg. API	34.4	43.4
Sulfur, percent	1.48	0.22
Carbon residue, percent	2.45	0.06
Fractionation of charge and product gas, C_3 and C_4, percent by volume	1.1	3.2
Debutanized, 300 F. End-Point Gasoline:		
Yield, percent by volume	19.3	29.4
Inspections:		
Gravity, deg. API	62.4	63.7
Sulfur, percent	0.15	0.055
ASTM octane number (D 357, Motor method), without TEL addition	55.3	62.7
Naphtha (300 to 410 F.):		
Yield, percent by volume	11.6	15.9
Inspections:		
Gravity, deg. API	47.7	46.6
Sulfur, percent	0.60	0.03
ASTM octane number (D 357 Motor method), without TEL addition	37.2	46.6
Furnace Oil (410 to 670 F.):		
Yield, percent by volume	27.3	35.6
Inspections:		
Gravity, deg. API	35.6	33.4
Sulfur, percent	0.83	0.23
Bottoms (670 F. and heavier):		
Yield, percent by volume	40.7	15.9
Inspections:		
Gravity, deg. API	19.4	21.1
Sulfur, percent	1.54	0.39
Carbon residue, percent	6.3	1.35

considerable attention, particularly because they offer attractive possibilities for more economical catalyst regeneration. However, the use of a fluid bed, either intermittent or continuous, is obviously limited to operations at severities sufficiently great that the product is completely vaporized at the outlet of the reactor. Furthermore, the problems associated with the introduction of a partly vaporized heavy feed into the catalyst bed, the inherent complications of fluidized operation at the pressures involved, and the necessity for substantially complete catalyst retention make it questionable whether fluidized operation offers any net advantages for this process.

Although the aforementioned and other modifications are continuing to be investigated, it now appears that a simple downflow fixed-bed type of operation is preferable for the stocks most likely to be processed in the near future and for the operating conditions which appear to be optimum for them. Especially designed reactors have been developed to permit the regeneration of the catalyst at minimum cost.

Typical Results—As an example of the results which can be expected when whole crude oils are being processed, Table 1 presents data obtained during a typical pilot-plant run when charging West Texas crude, and Table 2 presents corresponding results from Kuwait crude. Inspection of the data shown in Tables 1 and 2 indicates that the most striking change in product distribution is the pronounced decrease in the amount of the bottoms fraction. For example, for Kuwait crude the 670+ F. bottoms fraction has been reduced from 49.4 percent by volume of the crude to 20.4 percent by volume of the product, with a corresponding increase in the yield of distillates and a significant improvement in the quality of the bottoms fraction. The ASTM octane numbers (D 357, motor method), without TEL addition, of the gasolines and naphthas have been increased, but not sufficiently to eliminate the need for catalytic reforming. The sulfur content of all fractions has been considerably reduced, the overall reduction being in the range of 80 to 85 percent. In addition, it will be noted that the carbon residue of the 670+ F. bottoms from hydrodesulfurization processing is of the order of 1 percent; thus, this fraction may be charged directly to a catalytic-cracking unit.

In Table 3 data are presented from the processing of Kuwait vacuum-tower bottoms and a blend of these bottoms with a high-sulfur catalytic furnace-oil distillate in proportions which roughly correspond to a No. 6 fuel oil. Results are given for operation at two severities on each charge stock. In the more severe operations presented in Table 3, much more than 90 percent of the

TABLE 2

Typical Results of HDS Processing of Kuwait Crude Oil

Yields, Percent by Weight on Charge:	
Dry Gas	4.65
Depropanized liquid product	89.63
Catalyst carbon	3.29
Sulfur removed	2.15
Total	99.72
Hydrogen consumption, scf per bbl. on charge	499

	Crude Charge	HDS Product
Data on Charge and Total Liquid Product:		
Yield, percent by volume	....	96.0
Desulfurization, percent	....	82.5
Inspections:		
Gravity, deg. API	30.8	42.4
Sulfur, percent	2.61	0.46
Carbon residue, percent	5.3	0.06
Fractionation of charge and product gas, C_3 and C_4, percent by volume	2.4	3.2
Debutanized, 300 F. End-Point Gasoline:		
Yield, percent by volume	16.4	25.8
Inspections:		
Gravity, deg. API	70.3	68.9
Sulfur, percent	0.04	0.03
ASTM octane number (D 357, Motor method), without TEL addition	47.2	53.9
Naphtha (300 to 410 F.):		
Yield, percent by volume	9.2	14.9
Inspections:		
Gravity, deg. API	50.5	47.8
Sulfur, percent	0.16	0.05
ASTM octane number (D 357, Motor method), without TEL addition	23.4	39.8
Furnace Oil (410 to 670 F.):		
Yield, percent by volume	22.6	35.7
Inspections:		
Gravity, deg. API	37.3	34.3
Sulfur, percent	1.21	0.47
Bottoms (670 F. and Heavier):		
Yield, percent by volume	49.4	20.4
Inspections:		
Gravity, deg. API	14.4	20.9
Sulfur, percent	4.11	0.84
Carbon residue, percent	9.8	0.88

TABLE 3

Typical Results of HDS Processing of Kuwait Reduced Crude Oil and a Blend with FCC* Furnace-Oil Distillate

	100-PERCENT KUWAIT REDUCED CRUDE OIL			71.2-PERCENT KUWAIT REDUCED CRUDE OIL 28.8-PERCENT CATALYTIC FURNACE-OIL DISTILLATE		
		PRODUCT			PRODUCT	
	Charge	Severity 1	Severity 2	Charge	Severity 1	Severity 2
Yields, Percent by Weight on Charge:						
Dry gas		1.5	6.4		3.3	5.2
Depropanized liquid product		91.7	82.7		91.9	87.2
Catalyst carbon		2.4	6.4		2.2	3.3
Sulfur removed		3.8	5.1		3.4	4.7
Total		99.4	100.6		100.8	100.4
Hydrogen consumption, scf per bbl. on charge		650	1140		745	930
Data on Charge and Total Liquid Product:						
Yield, percent by volume		101.8	99.3		101.3	100.9
Desulfurization, percent		69.9	92.5		68.2	91.8
Inspections:						
Gravity, deg. API	5.8	20.8	33.2	10.7	25.2	32.8
Sulfur, percent	5.45	1.64	0.41	4.87	1.55	0.40
Carbon residue, percent	19.8	8.43	1.09	15.2	4.56	1.73
Fractionation of charge and product gas, C_3 and C_4, percent by volume		0.5	1.3		1.0	1.6
Debutanized, 300 F. End-Point Gasoline:						
Yield, percent by volume		6.5	14.9		7.5	16.0
Inspections:						
Gravity, deg. API		62.8	61.6		65.6	60.4
Sulfur, percent		0.17	0.1		0.32	0.22
Bromine number		19.4	4.0		19.8	8.0
ASTM octane number (D 357, Motor method), without TEL addition		54.0	50.5		53.4	48.8
Naphtha (300 to 400 F.):						
Yield, percent by volume		5.2	11.0		7.9	12.6
Inspections:						
Gravity, deg. API		43.9	44.4		43.1	43.1
Sulfur, percent		0.11	0.03		0.15	0.04
Bromine number		13.0	3.3		12.8	6.0
ASTM octane number (D 357, Motor method), without TEL addition		46.4	46.5		56.4	54.0
Furnace Oil (410 to 670 F.):						
Yield, percent by volume		19.3	41.4	28.8	42.4	46.5
Inspections:						
Gravity, deg. API		30.8	32.3	22.7	28.1	28.7
Sulfur, percent		0.54	0.16	2.66	0.96	0.29
Cetane number		45	44	28	39	36
Cracking Stock, 670 F. to:		925 °F.	950 °F.		940 °F.	920 °F.
Yield, percent by volume		21.1	27.3		25.1	2.03
Inspections:						
Gravity, deg. API		21.3	20.8		19.9	17.8
Sulfur, percent		0.93	0.42		1.39	0.81
Carbon residue, percent		0.21	0.59		0.67	0.78
Bottoms:						
Yield, percent by volume	100.0	47.4	4.1	71.2	16.1	3.0
Inspections:						
Gravity, deg. API	5.8	9.6	2.1	5.8	2.5	—3.5
Sulfur, percent	5.45	2.40	3.72	5.45	3.2	2.5
Carbon residue, percent	19.8	19.4	32.9	19.8	29.4	39.0

* FCC—Fluid catalytic cracking.

API Process Session

sulfur and carbon residue has been eliminated from the total liquid product. Appreciable quantities of all distillate products have been produced at the expense of the residual fractions. In the more severe operations only 3.0 percent and 4.1 percent of bottoms above cracking charge stock remain. During the charging of catalytic furnace-oil distillate with the bottoms, considerable desulfurization of the furnace oil is realized which, in certain circumstances, eliminates the need for separate furnace-oil treating operations.

As will be seen from the data given in Tables 1, 2, and 3, catalyst coke deposition is primarily a function of charge stock and operating severity. For mild severities with whole crude oils the coke production will amount to only 0.4 to 0.6 percent; for very severe operations as much as 3.0 to 4.0 percent coke may be laid down. From residual stocks, coke production is somewhat higher, ranging from 2.2 to 6.4 percent in the cases cited, with 2 to 3 percent envisioned for commercial operation.

Hydrogen is consumed in the process in several ways: actual incorporation into the product, combination with part of the sulfur to form hydrogen sulfide, reduction of catalyst, and solution in the liquid product. For crude oils the total hydrogen consumed for all purposes amounts to 200 to 500 scf per barrel on charge; for residual stocks it is more likely to be in the range of 400 to 1200 scf per barrel, again depending on the stock and specific operating conditions employed.

Temperature—Temperature as an operating variable has been investigated over the range 700 to 900 F. For most stocks the preferred processing temperature lies between 800 and 850 F. In this range the effect of temperature is relatively minor, the higher values giving slightly better desulfurization, more hydrocracking, and somewhat greater coke laydown. The net reaction involved is exothermic, and the temperature rise across the catalyst bed typically varies from 10 to 50 F., depending on the charge stock and other operating conditions. Accordingly, care must be exercised in the selection of the inlet temperature in order to avoid excessive temperatures in the bed.

Pressure—The pressure range which has received the most emphasis during this work is from 500 to 1000 psig, although both lower and higher pressures have been investigated to some extent. In general, increasing pressure gives improved results from desulfurization, hydrocracking, and coke-laydown standpoints; hence, the optimum processing pressure must necessarily be the result of an economic balance between the cost of the higher-pressure operation and the additional credits to be realized. Present indications are that pressures below 500 psig result in too-high coke laydown and too low a severity of operation to be economically attractive, and pressures above 1000 psig do not offer sufficient additional advantage to justify the higher costs involved.

Space Velocity—The most effective variable in controlling the severity of the operation is space velocity, which has been studied over the range of 0.25 to 4.0 volumes of oil per volume of catalyst per hour. Typical values for most stocks at severities of interest lie between 0.5 and 2.0 volumes per volume per hour. As space velocity is decreased, the severity of the operation is increased, with the degree of both desulfurization and hydrocracking increasing simultaneously.

Process-Period Length—Another method for effectively controlling the severity of operation in an existing plant is variation of the length of the process period. During the processing portion of the cycle a catalyst deposit consisting of sulfur and carbonaceous material is laid down on the catalyst, which results in a gradual but continuous reduction in its activity and, hence, in the quality of the product. Process periods, varying in length from one to several hundred hours, have been employed in this program. For crude oils and residues process periods from 4 to 24 hours in length appear to be optimum, inasmuch as they are long enough to avoid complicated switching mechanisms and excessive depressuring losses, and yet short enough to maintain catalyst activity at a satisfactorily high level.

Recycle-Gas Rate—The rate at which the hydrogen-rich gas is recycled has, in most cases, been held within the range of 2500 to 10,000 scf per barrel on charge. Lower recycle-gas rates result in increased coke deposition and a drastic decrease in the degree to which carbon residue is reduced. This latter effect is frequently accompanied by a dramatic change in the color of the total liquid product from a clear orange (3 to 4 NPA) to a dark opaque (7 + NPA). Higher recycle-gas rates do not appear to offer sufficiently improved results to justify the higher costs involved.

Metallic Contaminants—An immediate and pertinent question concerning any process for the handling of crude oils or residues is, of course, the effect of metallic contaminants on the activity and stability of the catalyst. The catalytic material used in the Gulf HDS process has been shown to be insensitive to the effect of metal contamination. One batch of catalyst was used in the pilot plant for well over a year, during which time many different stocks having a variety of characteristics and contaminating elements were processed. The activity of the catalyst at the end of this period was only slightly less than at the beginning, although a significant amount of metal contaminants had been deposited on the catalyst.

In an effort to accelerate any possible detrimental effect of metals, a high-metals stock containing 453 ppm of vanadium was charged to a sample of catalyst for a series of 70 cycles. During this period 240 volumes of oil were processed per volume of catalyst, and when the experiment was completed, a total of 11.5 percent of vanadium had been deposited on the catalyst. No significant detrimental effect of the contamination was observed.

Distinguishing Features—From the beginning a principal objective in this development has been the substitution of moderate pressure (1000 psig or less) for the higher pressure (3000 to 10,000 psig) conventionally employed in destructive hydrogenation processes. This objective has been pursued with the full realization that the practically nonregenerative operation which can be achieved in higher-pressure hydrogenation would no longer be possible at these lower pressures. This deliberate sacrifice of continuous, noncyclic operation for moderate operating conditions has characterized this work. The Gulf HDS process thus effects an increase in the hydrogen-to-carbon ratio of heavy crude oils and residues not only by increasing the hydrogen content, but also by decreasing the carbon content. Processing conditions are

such that moderate amounts of carbon are deposited on the catalyst. These amounts are, of course, somewhat less than those encountered in catalytic cracking of similar stocks.

It should be pointed out that the moderate pressures employed in the Gulf HDS process are not counterbalanced by large, compensating increases in hydrogen-to-oil ratios. The hydrogen circulation rates normally employed are in the range of 2500 to 10,000 scf per barrel on charge, which are similar to those employed in catalytic reforming. Both of these features, viz., low operating pressures and low hydrogen circulation rates, are contributing factors in the relatively low hydrogen consumption which characterizes the Gulf HDS process.

A process of the present type, which requires periodic catalyst regeneration, necessarily imposes severe thermal stability requirements on the catalyst. These requirements have been met successfully through the development of very rugged and stable catalysts which have been regenerated periodically for more than a year with satisfactory results. These catalysts also have unique stability toward heavy-metals poisoning and, hence, are well adapted to the processing of high-vanadium-content heavy crude oils and other residual stocks.

Extensive work has shown a definite correlation between the reactivities of charge stocks and their respective sulfur contents. For example, under the same operating conditions, a high-sulfur residual fraction like Kuwait vacuum-tower bottoms is converted to lower-boiling fractions to a considerably greater extent, and with a higher degree of desulfurization, than low-sulfur residuums such as those from the Gulf Coast. On the basis of this correlation it may be speculated that under hydrodesulfurization conditions the principal points of hydrocracking attack are the carbon-sulfur bonds in the molecules. This hypothesis helps to explain how it is possible to achieve the high degree of hydrocracking and desulfurization under the moderate conditions which characterize the process.

Engineering and Economic Aspects—In the development of the Gulf HDS process, engineering and economic evaluations have been closely coordinated with experimental operations. The first of these studies provided the basis for the decision to construct the 50-barrel-per-day pilot plant at Gulf's Port Arthur refinery. Since that time numerous studies have been made of the engineering and economic aspects of this process by the various groups concerned within Gulf and by The M. W. Kellogg Company, who have cooperated in some phases of the latter stages of the development and who are handling the licensing of the process. These investigations have been directed primarily toward the processing of two principal crude oils, West Texas and Kuwait, as well as various fractions and blends of fractions from these crudes. Several detailed process designs have been made. These have, in general, followed two basic patterns representing variants of fixed-bed catalytic and fluid catalytic techniques.

TABLE 4

Chemical and Utility Requirements for the Gulf HDS Process

	West Texas Crude Oil	Kuwait Vacuum Bottoms Light Catalytic Furnace-Oil Distillate Blend
Type of Unit	Fixed-bed	Modified fixed-bed
Chemicals, cent per barrel:		
HDS catalyst	2.8	6.8
Hydrogen production catalysts	0.2	0.6
Monoethanolamine	0.5	1.6
Total chemicals	3.5	9.0
Utilities, units per barrel:		
Fuel gas,* (FOE†), per barrel	0.08	0.13
Power, per Kwh	1.03	0.97
Cooling water, 1,000 gallons	1.46	3.75
Boiler feed water, 1,000 gallons	0.01	0.02
650-pounds steam, 1,000 pounds	...	0.13
300-pounds steam, 1,000 pounds	0.09	0.18

* Includes process gas for hydrogen manufacture.
† FEO= fuel-oil equivalent.

The most advantageous design for a given application has been found to be dependent upon the type of stock being processed and the severity of the operation. In a situation where there is a relatively slow rate of catalyst deactivation as a result of the deposition of carbonaceous deposits, it is felt that a conventional fixed-bed reaction system is the best design. The fixed-bed system is particularly suitable for low coke operations inasmuch as it provides a simple means for conducting the catalyzed reaction between oil and hydrogen; however, it requires relatively costly and complex procedures for catalyst regeneration. Where rapid catalyst deactivation occurs and frequent regenerations are required, fluidized catalyst systems have been investigated. This type of system would make it possible to operate continuously with a catalyst of constant activity and to regenerate the catalyst easily and efficiently. Problems of catalyst retention make the reaction vessels costly, however, and the control of such a system becomes complicated. Development work is in progress on a design which may make it possible to realize many of the advantages of both the fixed- and fluid-bed systems without the corresponding disadvantages.

As a result of this work the conclusion has been reached that several hydrodesulfurization operations are of commercial interest. One of these is the hydrodesulfurization processing of whole West Texas crude oil, and another is the processing of a blend of high-sulfur catalytic furnace-oil distillate and heavy vacuum bottoms from Kuwait crude oil, as described hereinbefore. Hydrodesulfurization treatment of whole crude oil is best suited to moderate-size new refineries of, say, 20,000- to 25,000-barrel-per-calendar-day capacity. For existing refineries, or for larger-size new refineries, the economics appear to favor charging residual fractions or blends of residual fractions with catalytic cycle stock.

As an indication of the process economics, it is estimated that a 20,000-barrel-per-calendar-day fixed-bed unit for whole West Texas crude oil would require an investment of approximately $500 per barrel of daily capacity, a direct operating cost of 25 cents per barrel, and a total operating cost (including 10 percent depreciation and all fixed charges) of 50 cents per barrel. Correspondingly, a 20,000-barrel-per-calendar-day fixed-bed unit to process a 71- to 29-percent blend of Kuwait vacuum-tower bottoms and light catalytic cycle oil would require an investment of approximately $800 per barrel of daily capacity, and have a direct operating cost of 75 cents per barrel and a total operating cost of $1.10 per barrel. These investments and operating costs include complete facilities for the manufacture of hydrogen. They

Gulf HDS Process . . .

would, of course, be reduced considerably if byproduct hydrogen were available, as it is today in many cases. The costs for whole West Texas crude oil assume a Gulf Coast refinery location; those for the Kuwait blend assume an East Coast location. Summarized chemicals and utilities consumptions are given in Table 4.

The aforementioned costs are admittedly sizeable, but they are balanced by very sizeable credits. These are of sufficient magnitude that, when these units are incorporated in complete refineries, the studies indicate the refineries with the Gulf HDS process would have, even under present circumstances, payouts on investment comparable with those for the best means of conventional processing.

Original presentation was before the API Division of Refining meeting, St. Louis, May 11, 1955.

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More About Processes . . .

Hydropretreatment of catalytic reformer feed: Here's another hydro-pretreatment process which has been developed to remove catalytic reformer contaminants from feed stocks. The process uses hydrogen produced in the reformer to treat the naphtha which passes in sequence through the "guard" case, contaminant stripper and reformer. Almost complete desulfurization is achieved at high space rates with any of a wide variety of feed stocks including virgin naphthas, thermal naphthas, and naphtha-kerosine cuts. The process was developed to work with the Houdriformer; at the present time all of the Houdriforming units in operation are equipped with hydro-pretreating sections. Two units are in operation (D. H. Stevenson and G. A. Mills, Houdry Process Corporation, Marcus Hook, Pa.)

Unifining: This is another popular process for purifying petroleum fractions through the use of hydrogen and a cobalt-molybdate catalyst. This discussion showed the results of actual commercial operations and demonstrated the process as a proven refining technique. ("Unifining—A Proven Refining Technique," Davis Read and M. J. Sterba, Universal Oil Products Company, Des Plaines, Illinois; and A. E. Kelley and G. H. Hemmen, Union Oil Company of California, Brea, California.)

Vapor-phase hydrodesulfurization: This Shell process is an economical alternative treating method which has been proved by nearly ten years of commercial operation. Capital and operating costs are low and in contrast to acid treating, volumetric yields are more than 100 percent. The process proved itself during World War II as an economical tool for producing aromatic base stock for aviation gasoline from catalytically cracked light naphthas.

Since the end of the war the process has been used to desulfurize selectively cracked naphthas in order to make them suitable for motor fuel blending. Here commercial operation has been successful in reducing sulfur 60 to 70 percent, with only a small decrease in leaded F-1 octane number but with a corresponding increase in leaded F-2 rating, while a stable gasoline was produced in all respects. The process has also been used to prepare mineral spirits and light furnace oil of low sulfur, good color, and good odor from straight-run stocks derived from high-sulfur crude. ("Vapor-Phase Hydrodesulfurization Applied to Cracked Naphthas and Light Straight-run Intermediates," M. D. Abbott, G. E. Liedholm, and D. H. Sarno, Shell Development Company, Emeryville, Calif.)

Sulfur problems: The newer crude discoveries contain large quantities of heavy residua and all or most of the products are high in sulfur. Substitution of such a high-sulfur crude for an equal amount of crude which has little residuum and low sulfur would cause serious upsets in the refinery yield structure, and would also cause product quality degradation and corrosion problems. The Fluid Coking process and the Hydrofining process were shown to join hands in providing an economic solution to the problem of adding high sulfur crude oil to a low sulfur refinery. The heavy fuel oil yield is tripled—16½ percent vs/ 5½ percent—when 25,000 barrels per day of heavy high sulfur crude oil is substituted for a like amount of light low sulfur crude oil in a hypothetical 100,000-barrel-per-day Gulf Coast refinery. The fluid coking process reduces the high residual fuel oil yield while making middle distillates, gasoline, catalytic cracking feed stocks, and a small amount of by-product coke. The addition of a fluid coker to the hypothetical refinery, which is running a 25-75 mixture of high and low sulfur crude oils, increases the yield of middle distillates by some 12,000 barrels per day. ("Processing of Heavy High-Sulfur Crude Oil in a Low-Sulfur Refinery," W. H. Winslow, Esso Standard Oil Company, Baton Rouge, La.; and John Weikart, Esso Research and Engineering Company, Linden, N. J.)

Hydrogen uses: The refiner's interest in hydrogen has been intensified by increased availability of catalytic reformer hydrogen at locations throughout the United States. Significant consumption of hydrogen for refining petroleum stocks, such as gasoline or fuel oils or the hydrogenation of coal into hydrocarbons, will overshadow the chemical uses of hydrogen. The "chemical" outlets can be classified into uses where hydrogen is not associated with carbon monoxide, and uses where it is associated with this material ("Hydrogen—Its Market and Potential Uses," Robert L. James, Arthur D. Little, Inc., Cambridge, Mass.)

Hydrogen purification: Hydrogen separation from hydrocarbon gases is no new process, dating back to 1900 in Europe. Demand for hydrogen by the chemical industry has been steady ever since. The new feature since the last war is the recovery of hydrogen from reformed hydrocarbon gases and refinery off-gases. Several plants are now under construction using Platformer gases as a source of hydrogen and one has been completed. The future for these hydrogen-rich refinery gases lies not only as a source of ammonia, urea and other fertilizers but for the chemical industry in general. (J. T. Hugill and F. G. Kerry, Spaco, Inc., New York.) ##

Corrosion Session

Neutralizers and Inhibitors Today

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MANY ARTICLES have been presented in the past on the several phases of corrosion and the methods tried for combating them. Here is summarized some of the practices in use today in such a manner that they will be of value as reference material.

Corrosion Prevention—There are several methods for combating corrosion. Among them are: *(a)* additional thickness of metal (corrosion allowance); *(b)* more resistant metals and alloys; *(c)* protective linings; *(d)* cathodic protection; *(e)* alkaline neutralizers; and *(f)* inhibitors.

This discussion will include only the use of neutralizers and inhibitors.

Several neutralizers are in use at the present time to combat corrosion. The principal ones are caustic soda, sodium carbonate, ammonia, and ammonium hydroxide for low-temperature service. Lime is being used primarily for high-temperature corrosion in thermal cracking units. For special cases the petroleum phenols, naphthenic soaps, triethanolamine, among others are being used.

Neutralizers—*Caustic Soda:* Caustic soda (sodium hydroxide) has been employed for many years and has advantages as well as disadvantages. An aqueous solution frequently is injected into the crude-oil charge line to a distillation unit to neutralize any hydrogen chloride evolved by thermal decomposition of salts in the crude oil. There also is evidence to indicate that caustic will react with the magnesium and calcium chloride to form the stable sodium chloride and the corresponding hydroxide. The protection afforded by the caustic probably is a combination of these effects. In general practice, the caustic is added to the hot crude line just ahead of the flash drums or crude tower in order to lessen the possibility of caustic embrittlement in furnace tubes and other equipment. It has been proven that the introduction of caustic ahead of furnace tubes can cause excessive coking and high tube metal temperatures. This fouling is caused by the free caustic in the system. Fouling may be expected if any excess caustic is used over that actually required for the reaction with the acidic elements present.

Caustic is frequently added to the desalters when these are used. It affords corrosion protection to the desalter if the effluent water has a low pH. Also the efficiency of the desalting operation is improved if the pH is maintained in the range of 7 to 8.

Large quantities of caustic are used to neutralize (wash) acidic oils after acid treatment, sulfur-dioxide extraction, and the like. Caustic washing of sulfide-bearing distillates from sour crudes is a common practice and helps to reduce corrosion of tanks in rundown service. Some refiners have reduced the corrosion of crude-oil storage tanks by washing the crude with caustic to remove the free hydrogen sulfide. This affords little protection to the units because the major portion of the acidic elements are not released until the crude oil has been heated. In the past some refiners have attempted to inject caustic into the overhead streams. The neutralization is needed at the point where condensation occurs, and the caustic must be injected ahead of this point. The good contact necessary for complete neutralization requires that a fine dispersal spray system be used for the caustic injection. This practice is little used because ammonia is quite volatile and more adaptable to vapor-phase neutralization. The best argument for the use of sodium hydroxide is the relative ease of handling. It requires little mixing equipment and may be used in varying concentrations, whereas the concentration of sodium-carbonate solutions is limited by solubility.

Sodium Carbonate: Sodium carbonate (soda ash) is another neutralizer which has won considerable favor. Frequently it is preferred to caustic for use in desalting equipment because it forms an emulsion which is broken more easily and results in less water carryover. This advantage is lessened somewhat by the lower concentrations usually involved. Care must be exercised when using soda ash in high-temperature streams to insure that the carbonate does not precipitate through evaporation of the solution and cause plugging of lines and equipment. Experience has shown that sodium carbonate in the amounts generally needed will not cause excessive coking or high tube-metal temperatures in furnaces. Moreover, there is no danger of caustic embrittlement with sodium carbonate. These two reasons are generally given by those advocating the use of sodium carbonate.

Those refiners opposed to sodium carbonate report two disadvantages. In some cases it is feared that sodium

TABLE 1—Application of Neutralizers Alone

Case Number	Type of Unit	Gravity (Deg. API)	CHARGE STOCK: Sulfur Percent by Weight	CHARGE STOCK: Salt (Pounds per 1,000 Bbl.)	CHARGE STOCK: After Desalter (Pounds per 1,000 Bbl.)	Neutralizer	Equipment Protected	Method of Injection	Control	Disabilities	Cost (Dollars per Barrel)	REMARKS
A	Pipe still	32	1.6	33	7	Sodium carbonate (10 to 20 lb. per 1,000 bbl.)	Furnace transfer line and bottom of fractionator.	Gas oil or water slurry pumped to exchanger train.	.....	Need additional equipment, material and controls.	.....	Use sodium carbonate because sodium hydroxide fouls furnace tubes; also danger of caustic embrittlement.
B	Pipe still	36	0.23	40 (winter) 20 (summer)	1.4	Sodium carbonate (20 lb. per 1000 bbl.)	Overhead equipment	Water solution to exchanger train, second dose after desalter.	pH 8.8 (desalter), pH 7.0 (overhead)	Plugging of desalter effluent line.	.00058	Sodium carbonate has less water carryover from desalters than sodium hydroxide.
D	Pipe still	37.8	0.20 0.45	20 40	2 to 4	Sodium carbonate (30 lb. per 1000, bbl.)	Overhead equipment.	Water solution	pH 7.8 to 9 (brine from desalter)	None	.008	Sodium carbonate forms better emulsion. Also use ammonia in overhead.
C	Pipe still	40	0.30	55	Trace	Sodium hydroxide (7 lb. per 1,000 bbl.)	Vacuum heater, outlet line, vacuum-tower internals.	Water solution.	.....	Excessive coking.	.0002	.....
E	Crude-oil unit	30	.....	.....	.....	Sodium hydroxide (30 to 100 lb. per 1,000 bbl.)	.....	Water solution into furnace charge line.	.....	Excessive fouling and coking of furnace tubes.	.....	Experimental tests discontinued.
F	Battery crude-oil still	32	1.5 to 2.25	100 to 150	5 to 10	Sodium carbonate (7.5 lb. per 1,000 bbl.)	Condenser coils, run-down lines, crude-oil preheat exchanger.	Water solution into crude-oil line ahead of crude-oil flash tower.	pH 6 to 6.5	None.	.00015	16 lb. per 1,000 bbl. sodium hydroxide used in desalter. Prior to use of sodium carbonate, sodium hydroxide caused excessive coking.
G	Battery crude-oil still	30 to 31	0.25 to 0.50	25 to 30	No desalter	Sodium hydroxide (20 lb. per 1,000 bbl.)	Condenser coils, run-down lines, crude-oil preheat exchanger.	Water solution to crude-oil line ahead of crude-oil flash tower.	pH 6 to 6.5 (effluent water)	Some excessive coking and rupture of tubes.	.0004 (chemical cost)	No caustic embrittlement has been experienced.
I	Thermal cracking	29	0.1 to 0.2	Feed is cycle gas oil from thermofor unit		Calcium oxide (¼ lb. per bbl.)	Furnace-bottom evaporator and bubble towers.	Gas-oil slurry (1.5 lb. per gal.) ahead of towers and furnace.	0.25 lb. per bbl.	High ash content in fuel oil.	.00188	Stable effective neutralizer less required than sodium carbonate. No caustic embrittlement.
J	Combination crude-oil cracking and coking	32	1.5 to 2.2	100 to 150	5 to 10	Ammonium hydroxide (0.016 lb. per bbl.)	Condenser equipment subject to dew-point conditions.	To crude-oil light- and crude-oil heavy-vapor lines.	pH 7.5 to 8.5	Ammonium chloride deposited and hydrolyzed to regenerate hydrogen chloride.	.00081	Superior to sodium hydroxide and sodium carbonate because it mixes better with overhead vapors.
K	Straight rerun unit	46	0.07	.....	.....	Ammonia (0.00171 F. per bbl.)	Overhead condensers.	1-percent water solution to top tower reflux.	pH 7.0 to 7.2	None	.000136	Ammonia has always been used with satisfactory protection.
L	Phenol extraction unit	22 to 27	1.25	Nil	.....	Sodium hydroxide (0.065 lb. 10-percent solution per bbl.)	Extract furnace tubes and line to flash tower.	10-percent solution to tower feed.	.....	Showed increased corrosion at high temperature in presence of phenols.	.0009	Caustic used to neutralize naphthenic acids; chosen because of high temperature involved.

TABLE 3—Application of Inhibitors to Combat Hydrogen Attack

Case Number	CHARGE STOCK: Gravity (Deg. API)	CHARGE STOCK: Sulfur (Percent by Weight)	CHARGE STOCK: Organic Nitrogen (Percent by Weight)	Crude-Oil Source	Type of Catalyst	Equipment Affected	Inhibitor	Control	Points of Injection	Other Methods	REMARKS
A-2	27.5	0.98	0.065	58 percent Gulf Coast 45 percent Mid Continent	M.S. synthetic	Debutanizer, reflux, depropanizer reflux, C_3 product accumulator.	Oil-soluble amine	1 to 2 qt. per 1,000 bbl. per day.	Debutanizer vapor line. Depropanizer vapor line.	None.	Inhibitor on trial. Have used 18-8 liners in vessels attacked.
D-9	26 to 29	0.97 (average)	0.069 (average)	West Texas Gulf Coast	Synthetic	Stabilizer feed and reflux drums, depropanizer reflux drum, depropanizer and debutanizer condensers, depropanizer feed exchanger.	Amine type	20 to 40 ppm in condenser water.	Air to fractionator vapor line. Water upstream of high-pressure contact condenser.	Water-wash air injection.	Wash—partly successful. Air—successful. Rate: 1,000 to 1200 cu. ft. per mmcf. Inhibitor—unsuccessful.
E-11	28	0.35	0.11	Illinois	Natural first year, synthetic since 1950.	Debutanizer overhead condenser.	Amine type	1 gal. per day in 11,000-bbl.-per-day feed stream.	To unstable gasoline upstream of feed preheat.	None.	Success is not determined.
F-12	28 to 30	0.30	0.072	Illinois	Natural	Contact condenser shell, stabilizer feed accumulator, top of absorber.	Amine type	1 gal. per mmcf.	Inhibitor to unstable gasoline transfer pumps. Water to fractionator and stabilizer vapor line.	Water wash.	Wash—not evaluated, plan air injection. Inhibitor—on trial.
G-13	30	0.50	.....	Texas Panhandle Sweet West Texas	Natural	Vapor-space fractionator, reflux drum, compressor gas cooler, feed section absorber, debutanizer reflux accumulator.	Amine type	2 gal. per mmcf.	Inhibitor to contact condenser. Water to compressor gas cooler.	Water wash.	Wash—fair success. Inhibitor—fair success.
G-14	30	0.5	0.3	West Kansas	Natural	Debutanizer reflux condenser and accumulator, absorber, lower section, compressor gas cooler.	Amine type	1 gal. per mmcf.	Inhibitor to fractionator vapor line, to compressor discharge, and to debutanizer vapor line.	Water wash, Saran and Ameroint coatings inside.	Wash—fair success. Inhibitor—fair success. Coatings—poor.
H-18	26	0.3 to 2.0	0.10	Texas East Venezuela Near East	Montmorillonite, halloysite	Contact condenser shell, debutanizer feed accumulator, overhead condenser, low section absorber.	Amine type	1 gal. per mmcf.	Inhibitor to fractionator vapor line and to compressor discharge. Water ahead of contact condenser and to debutanizer vapor line.	Water wash.	Wash—reduced corrosion. Inhibitor—not evaluated.
K-21	29.4	1.65	0.08	Arabian	SR natural	Contact cooler shell, stabilizer feed, accumulator, stabilizer reflux cooler, stabilizer reflux accumulator.	Amine type	1 gal. per 1,000 bbl.	Water to fractionator vapor line. Inhibitor to stabilizer vapor line to top absorber, to unstable distillate, and to contact cooler.	Water wash.	Wash—unsuccessful. Inhibitor—fair success. Air injection is being considered.
L-24	22	1.15	0.30	Los Angeles Basin Santa Maria San Joaquin	M.S. Synthetic	Compressor aftercooler, depentanizer, feed accumulator.	Sodium polysulfide	5 lb. per bbl. sulfur, 2.5 gal. per mmcf.	Water and polysulfide to inlet of compressor aftercooler.	Water wash.	Wash—successful. Polysulfide reduces probe activity 90 percent.
M-26	30.5	0.24	.....	Southern Louisiana East and West Texas	Synthetic	Lean-oil still condenser and reflux accumulator, top of depropanizer, depropanizer condenser and reflux drum.	Amine type	5/6 gal. per 1,000 bbl.	Inhibitor to vapor line of lean-oil still; also to depropanizer vapor line.	None.	Inhibitor—unsuccessful.

TABLE 2—Application of Neutralizers and Inhibitors

Case No.	Type of Unit	CHARGE STOCK: Sulfur (Percent by Weight)	CHARGE STOCK: Salt (Pounds Per 1,000 Bbl.)	CHARGE STOCK: After Desalting (Pounds Per 1,000 Bbl.)	Neutralizer	Inhibitor	Control	Points of Injection	REMARKS
1	Crude-oil distillation unit	0.28	11 to 33	No information	Ammonia (1 to 2 lb. per 1,000 bbl. as aqueous solution)	None	pH 7.5 to 8.5 (condenser water).	Overhead vapor line.	Ammonia alone reduced corrosion 50 to 75 percent.
2	Crude-oil distillation unit.	1.14	4.4 to 22	No information	Ammonia (aqueous solution).	Amine type	pH 7.5 to 8.5 (inhibitor: 1 to 2 qt. per 1,000 bbl.)	Ammonia plus inhibitor added to overhead vapor line. Inhibitor added continuously.	Inhibitor alone reduced corrosion 75 to 90 percent depending upon the pH.
3	Crude-oil distillation unit	1.50	11 to 55	No information	Ammonia (aqueous solution)	Amine type	pH 7.5 to 8.5 (inhibitor: 2 qt. per 1,000 bbl.)	Added to overhead line. Inhibitor added once per 8-hour shift.	Ammonia plus inhibitor reduced corrosion 85 to 95 percent.
4	Crude-oil distillation unit	0.17 to 0.48 (0.30 average)	3.3to4.4	No information	Ammonia (10.2 lb. per hour	Amine type	pH 7.5 to 8.2 (inhibitor: 0.4 gal. per 1,000 bbl.)	Inhibitor to overhead vapor line. Ammonia to bottom of crude-oil flash tower.	Reduced ammonia required from 18.8 to 10.2 lb. per hour with the use of inhibitor.
5	Crude-oil distillation unit	0.23	20 to 50	1.4	Ammonia (7 cu. ft. per hour)	Amine type	pH 7.0	Ammonia to gasoline vapor line. No information on inhibitor.	Have experienced hydrogen blistering on water and gas separator. Used gunite linings.
6	Crude-oil distillation unit	1.5 to 2.25	100to150	5 to 10	Ammonia (8 to 10 lb. per 1,000 bbl.)	Amine type	pH 7 to 8 (inhibitor: ½ to 1 gal. per 1,000 bbl.)	Ammonia to vapor lines near top of tower. Inhibitor to vapor-line naphtha overhead.	pH was 3 to 4 without ammonia. One unit, running high sulfur and naphthenic acid, has monel liner.
7	Crude-oil distillation unit	1.52	17	4.4	Ammonia	Amine type (test only)	pH to 7.5 (OH water)	.....	.....
8	Crude-oil distillation unit	0.4 to 0.5	22 to 44	1.1 to 4.4	Ammonia	.....	pH to 7.3	Ammonia to tower and overhead lines.	Sodium hydroxide used in desalter. Amine-type inhibitor has been tried; also sodium and calcium sulfonates.
9	Crude-oil distillation unit	0.6	.....	1.1	Ammonia	Amine type	pH to 7 (inhibitor; 5 gal. per day)	Ammonia to tower vapor lines. Inhibitor introduced in slugs.	Report of composition of salts after desalting; 50 percent magnesium chloride, 25 percent sodium chloride, and 25 percent calcium chloride.
10	Crude-oil distillation unit	0.5	100	1.5	Ammonia	Amine type	pH to 6.8 to 7.2 (inhibitor: 2.5 gal. per 1,000 bbl.)	Ammonia to overhead stream. Inhibitor to overhead stream.	Electrical desalter; 1.5 lb. sodium hydroxide per 1,000 bbl. crude oil added to hold desalter pH to 7.5 to 8.0.

carbonate will result in a higher sediment rate in the products. However, the principal deterrent is the additional equipment, materials, and controls needed to handle soda ash. These disadvantages can be partly offset by the fact that soda ash is slightly cheaper than caustic, as reported by *Chemical and Engineering News*, in December 1953. A survey of equations involved indicate that more than 32.5 percent by weight of soda ash is required for equal neutralizing value. Based on use of 50-percent solution of sodium hydroxide in tank cars as 1.0, the relative cost of sodium carbonate in various forms per car lot is as follows: in bulk form, 0.702, in bags, 0.855, and in barrels, 1.145. It is evident that considerable savings can be made if the facilities are available to handle the purchase in bulk form. In most cases the ease of handling dictates the use of carbonate in bag form. This is less attractive economically, but it still reflects a materials' saving of 15 percent, which will help defray handling costs. The equivalent protection without excessive coking seems to warrant the substitution of sodium carbonate for sodium hydroxide in hydrocarbon streams subject to furnace conditions.

Ammonia: The neutralizers previously discussed are nonvolatile and are not readily adaptable for neutralization in overhead systems. Adequate overhead-stream neutralization requires a fine dispersal if liquid neutralizers are used. This requirement makes some sort of atomizer mandatory for thorough contact and mixing. For this reason, ammonia—which is quite volatile—is preferred to caustic or sodium carbonate for the protection of overhead equipment. The ammonia is injected in both the aqueous form and as the anhydrous gas. Water is required for two purposes and must be added if there is not a sufficient amount carried over. First, the water is necessary to wash away the ammonium chloride and sulfide salts formed and thus prevent plugging of equipment by salt deposits. Secondly, the ammonium-chloride salt is unstable in the anhydrous form and readily breaks down in the presence of heat-regenerating hydrogen chloride. In water solution the ammonium-chloride salt is relatively stable and can be removed from the system in the water draw-offs. The sulfides are not very stable, even in water solution, and there appears to be a continual cycle of forming ammonium sulfide and then decomposition and regeneration of the hydrogen sulfide. For this reason an excessive amount of ammonia is required for adequate neutralization. This requirement makes the use of organic inhibitors economically attractive, inasmuch as they afford protec-

Meet the Authors

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API Corrosion Session

tion in solutions having a pH above 5. Considerable savings of ammonia can thus be achieved with modest quantities of inhibitors.

There is considerable evidence that the reaction products of the neutralization with ammonia may be a factor in overhead-system corrosion, particularly when processing crude oils of high chloride content. This is a complex problem, and it is difficult to estimate just how much corrosion is caused by the reaction products and how much results from the fact that the reaction is reversible. Heat will shift the equilibrium, as will insufficient quantities of ammonia. An accumulation of reaction products may affect the distribution of ammonia so that the equilibrium conditions cannot be maintained.

Another extensive use of ammonia is the injection of anhydrous ammonia into the vapor space of tanks in sour-crude-oil and sour-distillate service[6] in order to neutralize the hydrogen sulfide present. Laboratory experiments have indicated that stoichiometric amounts of ammonia are not required for corrosion protection because the ammonium salts dissolve in the water phase and have a buffering effect. One-tenth of the amount required for complete neutralization has been found to be beneficial. However, the actual benefits to be derived from such a program are somewhat controversial and warrant further investigation. Field tests are being conducted at the present time to clarify the situation and make definite recommendations.

The danger of stress corrosion when ammonia is used in systems containing copper should be considered. Stress corrosion may be serious, especially if the pH is above 7.0. However, no stress corrosion has been found in many instances where one would normally expect it. This is attributed by several authors to the presence of sulfides in the gas streams. It has been shown by experiment that hydrogen sulfide, butyl mercaptan, and carbon disulfide will effectively inhibit stress corrosion by ammonia.[8] Refinery experience indicates that both oxygen and water must be present for stress corrosion to occur. This requirement has been emphasized by experiences with copper-alloy tubes in the presence of ammonia. They did not crack in service, but they did crack after exposure to the atmosphere during turnarounds. In systems containing copper or brass equipment it is recommended that the ammonia be injected as far upstream from said equipment as is practical. This permits most of the ammonia to react before entering the susceptible equipment and thus lessens the danger of stress corrosion.

Lime: Lime is another neutralizer which has been used extensively in the past and still enjoys limited use today. It has been used as calcium hydroxide and as calcium oxide. Normally lime is injected in a gas-oil slurry with a concentration of 1.5 pounds per gallon of gas oil. The principal application is against high-temperature corrosion in thermal cracking units and viscosity breakers. It has proven generally satisfactory if added in sufficient quantities. However, the advent of high-sulfur crude oils has necessitated the use of larger and larger quantities of lime. Lime is advantageous because it is a stable effective neutralizer and a smaller amount is required than with sodium carbonate. It is preferred to caustic because there is no danger of caustic embrittlement with lime. The chief disadvantage of lime is sediment contamination of products. It has been reported[5] that quantities in excess of 250 pounds per 1000 barrels will cause a sediment problem. This usually necessitates the installation of filtering equipment to remove this sediment from the tar or fuel oils. Filtering expense must be included in the cost computations for lime addition.

The filter expense and the increased quantities of lime required for high-sulfur crude oils make the use of alloys more attractive for new equipment. However, for old equipment lime is used whenever it can be justified economically. The main factor in an economic study would be the sulfur content of the crude oil because this governs the amount of lime required.

Other Neutralizers: Other neutralizers have been used for special cases for which some particular property is required. Partly neutralized petroleum phenols have been used to neutralize sulfur dioxide in alkylate produced by the sulfuric-acid process. Of prime requisite here is an alkaline component which is soluble in the alkylate.

Naphthenic soaps or soap bottoms have been used to neutralize sulfur dioxide in cases in which an oil-soluble neutralizer is required. These saponified acids are separated and recirculated to the crude-oil towers where they react with the hydrogen chloride, forming sodium chloride and regenerating the acid. The acids stay in the bottoms until resaponified and normally have no corrosive effect at the comparatively low temperatures used in crude-oil distillation.

Triethanolamine is a highly alkaline product which is relatively nonvolatile and is completely miscible in water. It has been used to combat hydrogen chloride from contaminated streams in polyplants.

Inhibitors—Practically all refiners injecting ammonia into the overhead streams also inject an organic film-forming inhibitor. The principal inhibitors in use are of the complex organic amine type. Ammonia normally is added to maintain a pH of 6.5 to 8.0. This in itself affords fair protection, but the amine improves the protection and at the same time reduces the ammonia requirements. The function of the inhibitor is to form a protective film on the metal surfaces.

As a rule the maximum temperature for effective use of organic inhibitors is 450 F. because higher temperatures cause the protective film to deteriorate. There are inhibitors on the market which are reported to have better temperature characteristics. However, these have not been sufficiently evaluated to make a general statement concerning their use. In normal use these films are gradually washed away, and the additive must be renewed periodically. Most films are quite soluble in water having a pH of 5.0 or less. This can be explained by a change in the solubility of the inhibitor in the water present as the pH varies. Figure 1 shows the effect of this solubility on the distribution ratio of a common amine-type inhibitor in the oil and water phases. Consequently, in order to retain an effective film, the pH must be maintained above 5.0 by ammonia injection.[7] When an inhibitor is first added to a dirty system, its detergent action tends to suspend corrosion products and carry them along with the hydrocarbon stream. This has caused plugging of lines and should be duly considered when starting to use inhibitors. It has been recommended[7] that a large dosage of approximately 5 gallons per 1000 barrels be injected for the first

week, and then reduce to 3 gallons per 1000 barrels. After a few days reduce to 1 gallon per 1000 barrels which is about normal for most cases. This "slugging" is necessary for the initial buildup of the protective film. However, whenever plugging is probable, a very small amount initially and a gradual increase to the higher quantities tends to clean up the unit with less possibility of plugging. Following a shutdown the injection rate should be increased for three or four days until equilibrium returns. Several refiners report the use of amine inhibitors in amounts varying from 1 quart to 2.5 gallons per 1000 barrels. Although 1 gallon per 1000 barrels is suggested initially, the amount can be varied so long as adequate protection is maintained. This can be checked by analysis of the overhead water for iron or copper content. Optimum protection is obtained when the inhibitor is injected continuously. If this is impractical, slug additions should be used and repeated several times a day. In order to obtain good distribution of inhibitor the injection points should be located as far upstream of the condensing equipment as is practical.

The use of inhibitors will reduce the problem frequently caused by sulfides in the refinery waste. When the inhibitor is used, the hydrogen sulfide is permitted to remain in the gas phase for later removal and sulfur recovery. One author,[16] who reports that a normal dose of inhibitor is 1 quart per 1000 barrels of gross overhead flow, claims that in field trials the use of inhibitor at double this rate controlled corrosion in solutions having a pH as low as 3. This would make ammonia injection unnecessary in many cases. Inasmuch as the neutralizers account for much of the troublesome sulfides in the waste material, the waste problem is then reduced. There are many who will claim that this pH value is entirely too low. However, the principle is clear. By reducing the amount of neutralizer employed, the sulfides to the sewer can be reduced and the sulfur recovery improved.

The detergent action of the inhibitor can be very useful in keeping equipment clean. It reduces cleaning time, generally improves heat exchange, and helps eliminate fouling. Some refiners claim that the ensuing cleaner equipment alone justifies the expense of inhibitors.

Similar film-forming amines have been successful in combating carbonic-acid corrosion in steam-condensate lines. The principle involved is the same but, because it is not a hydrocarbon stream, it will not be discussed further.

Discussion of Data—The data presented herein are selected from the returns of questionnaires submitted at various times by the API Subcommittee on Corrosion. Inasmuch as each questionnaire was different the cases selected do not readily lend themselves to one table. Consequently three tables were compiled in an attempt to group the units according to their use of neutralizers and inhibitors. Table 1 includes units using neutralizers alone and covers mainly pipe stills, battery stills, and thermal cracking units. In Table 2 the units covered are exclusively crude-oil distillation units. The neutralizer is ammonia and is normally used in conjunction with an amine-type inhibitor. Some of these units also use caustic in the desalters. Table 3 illustrates the attempt to minimize hydrogen blistering in catalytic cracking and vapor recovery units by means of film-forming inhibitors.

Neutralizers Alone: A comparison of the data presented in Table 1 shows that the amount of neutralizer used and

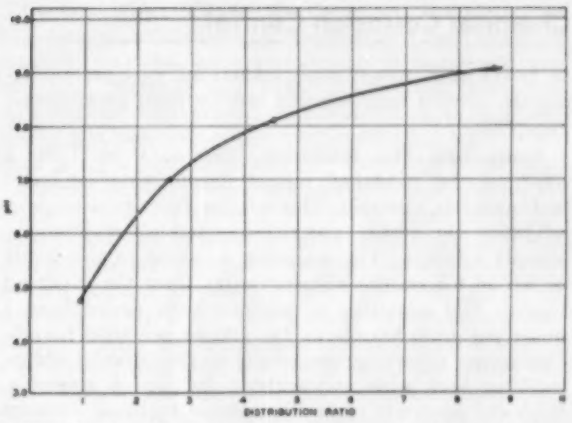

FIGURE 1—How pH affects the distribution ratio of an amine-type inhibitor in the oil and water phases.

the control of the pH varied widely in the different units. This results from the differences in crude-oil requirements which depend on the initial salt content, the efficiency of desalting, and the sulfur content, particularly at higher temperatures. The variations in desalting practices were widespread, and some of the pH controls indicated were on the desalter effluent. A cost per barrel is quoted in Table 1, but this has little value for comparative purposes because of the wide variation in conditions. In some cases additional neutralizer is added in the desalters and is not included in the cost. Other cases indicate that the addition may be to the desalter only, and adequate neutralization is not obtained.

There are, however, several points upon which there is agreement. Most refiners believe that the use of caustic in a stream subject to furnace conditions leads to excessive coking and high tube-metal temperatures. Many fear caustic embrittlement, although relatively few refiners have actually experienced embrittlement while using caustic as a neutralizer. However, the danger does exist with 18-8 or other austenitic tubes. The molten caustic present in such cases apparently attacks the austenitic materials more readily than it does carbon steel. For these two reasons sodium carbonate is preferred to caustic by many. Soda ash also is reported to form a better emulsion and to give more efficient desalting. On the other hand, the use of soda ash requires additional handling, materials, and controls.

Ammonia is preferred for addition to overhead systems because it mixes better with the vapor. It is volatile and can be added either as a gas or as a water solution. The water solution usually is preferred because water is needed to prevent plugging of lines and exchangers with the ammonia salts. Also the ammonia salts are more stable in water solution, and there is less likelihood of the salt decomposing to reform the corrosive acid. Lime is a stable effective neutralizer which is used primarily for higher temperatures in thermal cracking units. However, it is fairly expensive because of the large quantities required for high-sulfur crude oils. In addition, it frequently requires filtering of the product for salability. The use of alloy materials is replacing lime as a corrosion preventive

in newer installations. Some refiners are even reconsidering the present lime-injection systems from an economic viewpoint.

Neutralizers Plus Inhibitors: The data in Table 2 illustrate the combined use of film-forming inhibitors and ammonia injection. This relation exists because most inhibitors are soluble and require excessive additions in low-pH solutions. The ammonia is added to give a pH of 7.0 to 8.5 on the effluent water from the overhead system. The quantities of inhibitor used varied from 1 quart per 1000 barrels to 2½ gallons per 1000 barrels. One refiner reports quantitatively on the effect of adding inhibitor both with and without the use of ammonia. With the ammonia alone he reported corrosion reduced by 50 to 75 percent. The inhibitor alone reduced corrosion 75 to 90 percent depending upon the pH of the overhead. With ammonia plus inhibitor the corrosion was reduced 85 to 95 percent. These figures probably are representative and indicate a point of minimum addition of ammonia which will give adequate corrosion protection with a given amount of inhibitor. This view is generally supported by the literature, although there is some disagreement on the actual pH required for a stable effective film to form. Without exception the reported points of injection are the vapor lines ahead of the overhead condensers.

This method for corrosion protection is generally satisfactory with few inherent disabilities. The principal disadvantages are: (1) the possibility of plugging lines and tubes if the water carryover is not sufficient to wash away the ammonia salts formed; and (2) the possibility of the ammonia causing stress corrosion if copper-alloy equipment is present in the system. Frequently caustic or sodium carbonate is used in conjunction with ammonia in the unit to neutralize the desalter effluent for more efficient desalting. The use of caustic or soda ash in the feed streams decreases the amount of acid gas going overhead and thus reduces the ammonia requirements of the overhead system. This is particularly advantageous where large quantities of ammonia salts might cause plugging of the system.

Care must be exercised in the application of ammonia or inhibitor to assure even distribution throughout the system. This is particularly true if two or more lines are fed from a common injection point, e.g., two vapor lines from a tower, with injection to the tower only. One line may be higher or other factors may combine to give a high pH in one and a low pH in the other. The streams may mix and neutralize before the sample point is reached. This illustrates the fact that pH control and iron analysis are not always a true indication of the conditions at specific points upstream. They form a good guide but are not infallible. Wherever the possibility of unequal distribution exists, it is preferred that multiple injection points be used.

Inhibitors and Hydrogen Attack: Table 3 illustrates one attempt by refiners to eliminate hydrogen blistering in catalytic cracking and vapor recovery systems. The film-forming inhibitor is added to the vapor lines at a rate varrying from 0.5 gallon per million cubic feet to 2 gallons per million cubic feet. There is no need for neutralization because the pH is either neutral or alkaline in all the cases listed. If the solutions were acidic, it would be advisable to neutralize the stream with ammonia. The effectiveness of the inhibitors is somewhat dubious.

APPENDIX

Reactions and Equations—The principal reactions and the equation involved in the corrosion of iron, discussed in this paper, and the neutralization reactions are listed together for greater ease in comparison.

$CN^- + S^=_x = SCN^- + S^=_x$ (25)
$\frac{1}{2}O_2 + H_2 = H_2O$ (Oxygen depolarization) (28)
$\frac{1}{2}O_2 + 2e^- + H_2O = 2OH^-$ (cathode reaction near

A. *Hydrogen Chloride (Hydrochloride Acid)*

$2HCl + Fe = FeCl_2 + H_2$ (1)
$HCl + NaOH = H_2O + NaCl$ (2)
$2HCl + Na_2CO_3 = 2NaCl + CO_2$ (3)
$HCl + NH_4 = NH_4Cl$ (4)
$NH_4Cl + \text{heat} = NH_3 + HCl$ (5)

B. *Hydrogen Sulfide*

$H_2S + Fe + H_2O = FeS + H_2O + H_2$ (6)
$H_2S + Fe$ (over 500 F.) $= FeS + H_2$ (7)
$H_2S + 2NaOH = Na_2S + 2H_2O$ (8)
$H_2S + 2NH_4OH = (NH_4)_2S + 2H_2O$ (9)
$H_2S + 2Na_2CO_3 = Na_2S + 2CO_2$ (10)
$H_2S + Ca(OH)_2 = CaS + 2H_2O$ (11)
$(NH_4)_2S + \text{heat} = NH_3 + H_2S$ (12)

C. *Carbon Dioxide*

$CO_2 + H_2O = H_2CO_3$ (13)
$H_2CO_3 + Fe = Fe(HCO_3)_2 + H_2$ (14)
$H_2CO_3 + NaOH = NaHCO_3 + H_2O$ (15)
$2NaHCO_3 + \text{heat} = Na_2CO_3 + H_2O + CO_2$ (16)
$H_2CO_3 + Na_2CO_3 = NaHCO_3 + CO_2$ (17)
$H_2CO_3 + NH_4OH = (NH_4)HCO_3 + H_2O$ (18)

D. *Naphthenic Acid*

$2RCOOH + Fe = Fe(OOCR)_2 + H_2$ (19)
$RCOOH + NaOH = RCOONa + H_2O$ (20)
$2RCOOH + Ca(OH)_2 = (RCOO)_2Ca + 2H_2O$ (21)
$2RCOOH + Na_2CO_3 + H_2O = 2RCOONa +$
$CO_2 + H_2O$ (22)

E. *Other Reactions*

$FeS + 2H^+ = Fe^{++} + H_2S$ (23)
$FeS + 6CN^- + H_2S = Fe(CN)^{=}_6 + 2HS^-$ (24)
$CN^- + S^=_x = SCN^- + S^=_x$ (25)
air $+ 2S^= = S^=_x$ (polysulfide formation) (26)
$Fe + 2H^+ + 2H_2O = Fe(OH)_2 + 2H_2$ (27)
$\frac{1}{2}O_2 + H_2 = H_2O$ (Oxygen depolarization) (28)
$\frac{1}{2}O_2 + 2e^- + H_2O = 2OH^-$ (cathode reaction near neutral pH) (29)
$2H^+ + 2e^- = H_2$ (cathode reaction pH below 4.5) (30)
$M = M^{++} + 2e^-$ (anode reaction) (31)
$MgCl_2 + 2NaOH = 2NaCl + Mg(OH)_2$ (32)

Conclusions—(1) The presence of a water phase is necessary for appreciable corrosion to occur at low temperatures (below 500 F).

(2) The diffusion rate of oxygen through the protective film is the controlling factor in solutions having a pH in the range of 4.5 to 9.

(3) Caustic soda in streams subject to furnace conditions may cause excessive coking and high tube-metal temperatures.

(4) Caustic soda can cause caustic embrittlement (especially on austenitic steels) if any excess is used over the acid requirements.

(5) The corrosiveness of crude oil is greatly lessened by efficient desalting.

(6) More investigation is warranted to determine if reactions other than the hydrolysis of magnesium and calcium chlorides are responsible for some of the hydrogen-chloride formation in crude stills.

(7) The use of ammonia injection plus an inhibitor gives the best protection to overhead systems subjected to dew-point conditions.

(8) The use of ammonia may cause stress corrosion of copper-alloy equipment. This danger is lessened by the inhibiting action of sulfides if present and the added

requirements that both water and oxygen must present before stress corrosion can occur.

(9) The addition of film-forming inhibitors to systems now using ammonia will reduce ammonia requirements and at the same time result in a cleaner system.

(10) In general practice the film-forming inhibitors are added to give a ratio of 10 ppm to 20 ppm which is approximately 2 to 4 quarts per 1000 barrels.

(11) Ammonia should be used with the film-forming inhibitors to maintain a pH of at least 5.0 if the inhibitor is to be effective.

(12) Film-forming inhibitors will lessen the magnitude of hydrogen attack, but they cannot be depended upon to reduce it to a tolerable level.

(13) Sulfur and its compounds are responsible for most of the high-temperature corrosion encountered in refinery service.

(14) The use of lime has won disfavor because high-sulfur crude oils require larger amounts of lime and this necessitates filtering of the products for salability. This extra cost helps make lime economically unattractive.

Condensed from the presentation made before the API Refining Division, St. Louis, May 9-12, 1955.

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More About Corrosion . . .

Concrete Sewers: This discussion is based on an investigation of severe corrosion encountered in refinery condenser-water sewer systems. Corrosion of concrete sewer pipe has been a common problem in sanitary and industrial waste systems throughout the world for many years. Corrosion of so-called "clean water" sewers is comparatively new, and in this case entirely unexpected. Disintegration of concrete in direct contact with streams which contain sulfuric acid is also a well-known fact; however, this paper deals with corrosion in the vapor space of the pipe above the low water level. ("Corrosion of Concrete Condenser-Water Sewers," John Zahodnick, Esso Standard Oil Company, Linden, N. J.)

Cooling Water Treatment: Corrosion was so intense in a fresh-water cooling-tower system of a fluid catalytic cracking unit that early replacement of equipment was imminent. Normally such replacements would encompass such tubular equipment as water boxes, piping, and valves. But here the problem was magnified by the fact that, as a wartime expediency, the 45 tubular coolers and condensers in the system contained mild-steel tube sheets. Initially, local corrosion protection of tube sheets and water boxes with such devices as cathodic protection, and with organic and metallized coatings, was attempted. Inasmuch as this approach was only moderately successful, treatment of the water with a glassy phosphate was undertaken. Field evaluation showed that general corrosion was reduced approximately 50 percent, and pitting attack virtually was eliminated. In addition to the advantage of corrosion control, the phosphate treatment also improved heat transfer by the control of water-side fouling of exchanger surfaces. The savings obtained by corrosion protection and improved heat transfer far outweighed the expenditures for cooling-water treatment. ("Cooling Water Treatment Pays Off," R. J. W. Dilliplane, J. J. Hur, and D. A. Wrigley, The Atlantic Refining Company, Philadelphia.)

Hydrogen Blistering: Low-temperature hydrogen attack can be avoided by removing most of the sulfides, and a large portion of other acidic compounds, early in the process stream. Hydrogen sulfide is absorbed in a diethanolamine solution ahead of the second-stage compressor, and an extensive water wash is applied at the main fractionator overhead and at the first stage compressor aftercoolers. Of the 134,000 pounds per day of corrosive constituents, only 16,000 pounds per day reach the gas plant. Additional protection is provided for the deethanizer and depropanizer overhead equipment by caustic washing and drying of the feed to these towers. Two vulnerable locations are created: (1) the towers and overhead equipment of the diethanolamine stripper, and (2) the sour-water reclaimer. Both are protected by a corrosion inhibitor; also, the feed to the water reclaimer is neutralized. Polysulfide injection facilities are on standby to transform the cyanide promoter into harmless thiocyanate and to protect the vessel walls at the fractionator overhead and first stage compressor systems. Inhibitor facilities are available for additional protection at the absorber-demethanizer and at the debutanizer overhead equipment. ("Deterrence of Hydrogen Blistering in a Fluid Catalytic Cracking Unit," B. W. Neumaier and C. M. Schillmoller, Richfield Oil Corporation, Wilmington, Calif.)

Corrosion Survey: The API Subcommittee on Corrosion presented a literature survey on corrosion in cooling-water systems covering the years 1940 through 1953. Prepared as a guide to the refining industry which will indicate what already has been published covering this subject, the survey includes abstracts of various published articles which the subcommittee feels are of interest to the industry. These abstracts cover that phase of corrosion treatment which has proved satisfactory, or that which has been practiced by the industry. (H. F. McConomy, The Atlantic Refining Co., Philadelphia.) ##

API Corrosion Session

Maintenance Session

Contract Turnaround Work

Contractor working forces used to supplement refinery crews in meeting peak turnaround labor requirements.

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Union Oil Company of California, Rodeo, Calif.

THE EVER-INCREASING size and complexity of modern refining units demand large numbers of craftsmen for short lengths of time during periodic turnarounds. This is a demand which in some way must be adequately met. Because of it, the refinery maintenance department must either develop means of utilizing a fairly constant maintenance crew throughout the year, find a large temporary source of qualified craftsmen, or find some other solution.

Refineries which attempt to keep relatively constant craft working forces require closely organized coordination between operation, construction, and maintenance groups so that work requirements are kept within the ability of the maintenance department to produce. In contrast, this discussion deals with the use of general maintenance contractor crews as used to provide a fluctuating supply of craftsmen at our two major Union Oil refineries at Los Angeles and Oleum, Calif. This variable source of craftsmen recruited from local craft construction sources allows a flexible tailoring of manpower to meet current work requirements. The procedure has provided adequate peak manpower far in excess of normal maintenance demands, and has eliminated the problems inherent in a wide fluctuation in demand for qualified maintenance craftsmen.

Meet the Author

JOHN W. TOWLER, who manages Union Oil Company of California's refinery at Oleum, received his mechanical engineering degree from California Institute of Technology in 1930. He attended the Army's flying school at Kelley Field, Texas, graduating in 1931; after which he served in the Air Corps two years. He joined Union when he was released from active duty and served in various supervisory positions in engineering and maintenance until he was recalled in 1941. After his release from the Army in 1945, he sevred eight years as chief refinery engineer at Union's Wilmington refinery. In October 1953 he was appointed manager of the Oleum refinery.

Contributing Factors—Our problem is a difficult one because of several contributing factors. As refinery facilities are keyed to higher production rates and onstream time is stretched between shutdowns to maximize throughput, an occasional failure may bring several units down together—completely upsetting advance attempts to coordinate work requirements and manpower.

In addition to unexpected peak work loads the nature of jobs performed on various units may be such that the complement distribution from each craft varies considerably. Where one unit may require a majority of pipefitters to revamp piping, the next unit may require primarily boilermarkers to make exchanger, furnace, and tower repairs.

Even when shutdown schedules are met and advance plans for allocating manpower are followed, the work content of the shutdown may change abruptly after the turnaround has begun. Scheduled work may require postponement, due to unforeseen material, equipment, or design problems. Considerable additional work may be discovered when equipment is opened for inspection, in spite of detailed historical inspection records. Delays in the progress of a job may require added manpower to accelerate the completion according to schedule.

These constantly changing and often unpredictable shutdown manpower demands are always superimposed on a relatively constant amount of maintenance to other onstream units. Emergency repairs, routine servicing, preventive maintenance, dismantling, and minor new construction make continuing demands on manpower.

If we should look at the manpower demands for the period of a year, it might typically appear as shown in Figure 1. One will note the rapid changes in the numbers needed for various times during the year—they fluctuated from 275 to 675.

Possible Manpower Solutions—These variations in manpower requirements throughout the year fit different patterns in all refineries, of course, resulting from differing balances of: (1) the ability to provide, supervise, and utilize qualified craftsmen; (2) the required number, size, and spacing of turnarounds; and, (3) the amount and urgency of continuous daily maintenance work. Several solutions have been adapted by various companies.

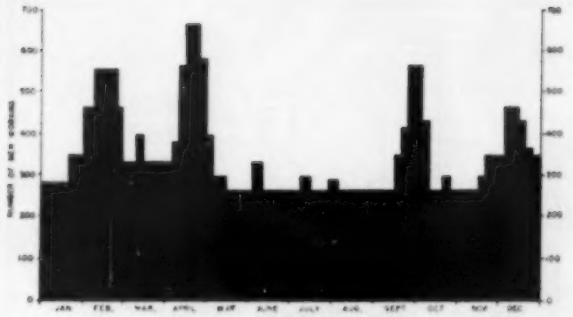

FIGURE 1—Typical refinery maintenance manpower requirements.

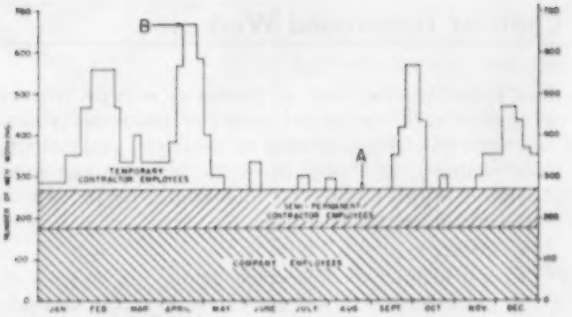

FIGURE 2—Variable contract maintenance manpower forces.

Maintain a Constant Crew

Before the API Division of Refining in May, 1954, F. C. King effectively described the approach taken by General Petroleum Corporation. A minimum basic crew was determined sufficient to handle a major unit turnaround in five days, plus a minor amount of running and standby maintenance. Maintenance crews were reduced to this number and held there by postponing jobs during turnarounds and adding approximately 15 percent minor construction work to the maintenance backlog between peak loads. All other minor and major construction was contracted. The development of a weekly work-priority list and a daily "hot sheet" enlisted the cooperation and detailed coordination between maintenance and operations which was absolutely essential to the success of this program. Resulting costs were very favorable, and security as well as craft morale benefited.

Fluctuate Company Manpower

Some refineries have found that long-range planning, coordination, scheduling, and the use of normally contracted construction work to balance, do not result in an economically constant work load. Backlogs become excessive and important new construction is delayed. It becomes necessary for them to temporarily increase, decrease, and redistribute craft manpower. The available manpower is increased by making temporary transfers from operations into the maintenance group and hiring primarily laborers from outside the company. At the same time laborers are temporarily elevated to helpers, helpers to craftsmen, and craftsmen to lead jobs or foremen.

Contract Turnaround Maintenance

Another commonly used method to staff peak turnaround manpower has been to define a portion or all of the work to be required during a shutdown and have it completed by an outside contractor. The contractor furnishes his own craft supervisors prior to the scheduled shutdown in order to survey the work and time requirements and to estimate the manpower needs. As the shutdown approaches, these supervisors build up their required crews and establish foremen from local hiring sources. These new and often extremely large multicraft crews are almost completely unfamiliar with the many essential refinery work methods and procedures. It therefore becomes extremely difficult to adequately and safely plan, coordinate, and record the multitude of maintenance activities which must be completed.

By experimenting with various possible solutions, Union Oil Company of California has developed still another answer to the problem of supplying manpower needs. We believe that our approach, which is described here, and which may be called "variable contract maintenance," to be the most satisfactory solution for us.

Variable Contract Maintenance—A permanently assigned company crew composes a portion of our normal central shops craft force and is augmented by a nucleus of contractor crews supplied under general maintenance contracts. This nucleus is used as a basis around which the contractors can expand out of local construction sources to meet variations in work load due to shutdown needs.

Several years ago this policy of providing manpower for refinery maintenance work was instigated. Refinery forces were augmented to a point where, under normal work-load requirements between major unit turnarounds, a small nucleus of contractor maintenance people would be kept in the refinery to meet the normal maintenance needs. This nucleus of contractor mechanics was the minimum number, craft by craft, which could be used during maximum manpower needs to act as general foremen, working foremen, etc., in a greatly expanded contractor-supplied work force. This nucleus of contractor personnel was considered as semipermanent, was hand picked for general all-around ability, and had the advantages of knowing the refinery, maintenance organization, operating units, and procedures.

Reference to Figure 2 indicates an approximate typical relationship between over-all company forces, nucleus contractor forces, and temporary craftsmen brought in for relatively short-duration periods. At point "A" there are no unit turnarounds—maintenance work load is normal. Company maintenance forces number 175, contractor nucleus forces are 100 in number, and there are no temporary contractor forces. Total maintenance people number 275. At point "B," which represents a major shutdown period, we still have 175 company maintenance people and 100 key contractor people but, in addition, 400 temporary contractor people, to make a total of 675. Each one of the 100 contractor nucleus takes a number of the temporary contractor mechanics and effectively makes use of this augmented crew during the peak manpower situation.

A breakdown of typical variations by craft is shown in Figure 3. (The dark areas indicate company employees; the cross-patched areas indicate semipermanent contractor employees; and the plain areas indicate temporary contractor employees.) Crafts requiring the largest varia-

tions, technical knowledge, or familiarity with the refinery are staffed with the largest nuclei of contractor craftsmen. The following discussion of contracts, organization, work planning, and work direction will give one some idea of our efforts to integrate these contractor forces with our own maintenance operations.

1. *Contracts*

General maintenance contracts at our Los Angeles refinery are written with one contractor to supply all crafts with the exception of painters, insulators, electricians, and brickmasons. These crafts are supplied by individual specialized contractors. At our Oleum refinery one contractor supplies all crafts with the exception of instrument men, who are company employees, and brickmasons, who are supplied by a specialized contractor. Until 1953, contracts had been cost plus a percentage for field-office expense, overhead, and profit. The percentage was based on direct labor costs. In 1953 the Oleum refinery contract was changed to a guaranteed percentage fixed fee on an estimated yearly payroll.

Direct labor rates are negotiated by the general maintenance contractors with local craft and labor unions. These higher construction rates, plus contractors' fees, are partially offset by the fringe benefits costs which must be considered a part of company craftsmen rates. The cost per hour of contractor labor does, however, exceed the cost per hour of company-employed craftsmen.

Supervision of contractor craftsmen is also subject to construction union contracts, which specify that work direction be given to union craftsmen by union foremen. Definite numbers of foremen are required, based on the size of crew, and foremen rates, as well, are specified.

2. *Organization*

The contract maintenance organization, as shown in Figure 4, is headed by a superintendent who is responsible to the Union Oil superintendent of maintenance and has general foremen or foremen in each craft reporting to him. During turnarounds crews may be large enough to have several subforemen reporting to each general foreman. The contractor superintendent is provided a field office for himself, his office manager, and several clerks. This office processes the hiring and release of all contractor craftsmen, keeps personnel and time records, and prepares contract payrolls and reports.

The company maintenance organization structure is unchanged by the presence of contract maintenance. Company shop foremen in each craft remain responsible for the quality and proper completion of all work of their crafts, whether performed by company or contract crews. The company shops are divided into two groups, reporting to two master mechanics who in turn report to the company superintendent of maintenance. A third group responsible for coordination and planning also reports to the company superintendent. This strictly staff group has the major functions of area coordination, daily and shutdown planning and scheduling.

3. *Work Planning*

Day-to-day maintenance is authorized on job orders by the operating departments. Work is defined by craft sequence in detail, estimated, and given priority by area foremen assigned to the five refinery zones. Orders are

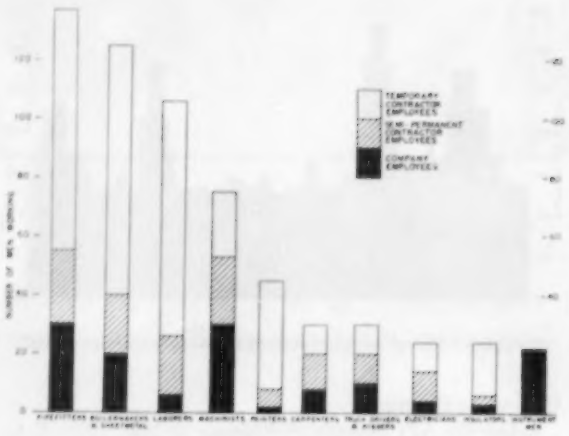

FIGURE 3—Typical variations in craft manpower forces.

immediately typed and distributed by the daily planning group to the craft shop foremen for inspection and requisitioning of nonstock material as necessary. After notification by the shop foremen that job material is available, the daily planning group prepares daily schedules for each craft. These schedules detail individual craft sequences by priority and are distributed one day prior to schedule to affected operating and maintenance foremen. Consideration is given to grouping at least 8 hours' work for each crew of men in as small an area as possible. More than enough work is scheduled for all available men, including the contractor craftsmen nucleus, so that the work backlog is always pushing the craft forces. Planning plays an important role in reviewing backlogs as well as current work and in recommending changes in the number of contract men. Changes are approved by the master mechanic, transmitted through the shop foremen, and executed by the contractor general foreman who lays men off or hires additional men from his local construction sources.

4. *Work Direction*

The planning group assumes that all scheduled work is completed as scheduled and proceeds with future schedules on that assumption unless otherwise notified by the company shop foremen. These daily craft schedules, therefore, are the initial basis for daily work direction in each shop. Either company or contractor craftsmen are assigned to cover the scheduled work and have authority to draw upon company stocks of materials, tools, and equipment. Company craftsmen are given instructions by shop foremen, while contractor craftsmen receive similar work direction through contractor subforemen. These contractor foremen, under the shop foremen's approval, prepare time-distribution sheets for accumulation of job charges and payroll payments. After delegating jobs in this manner to contractor foremen, the company shop foremen still remain responsible for the maximum utilization of all manpower, tools, and equipment. He is responsible to see that craftsmen receive adequate instructions, use proper methods, and are assigned alternate work when jobs do not proceed as scheduled. He also makes certain that correct tools and equipment are provided at the job site.

Turnarounds

Turnaround work is handled in much the same man-

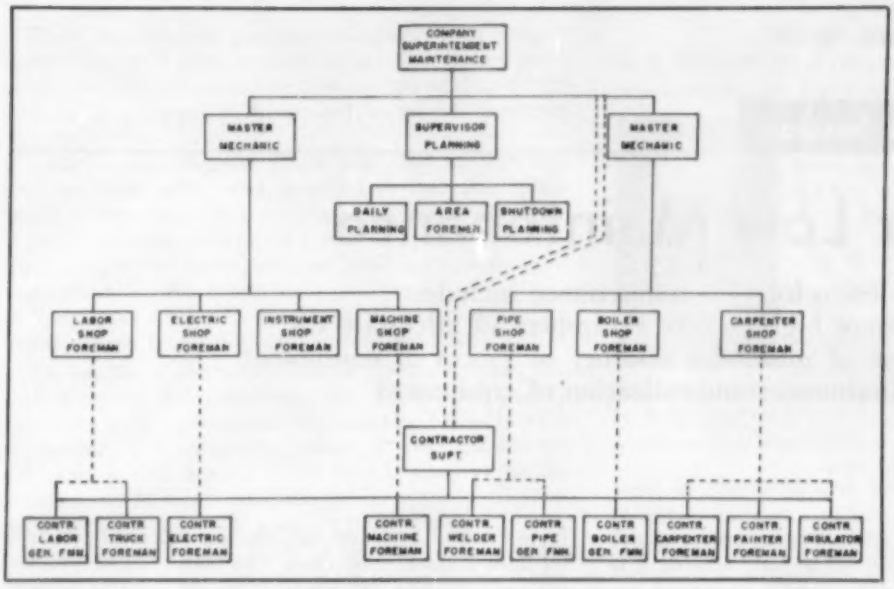

FIGURE 4—Maintenance organization.

ner. It is accumulated by the shutdown planning group, where it is finalized into a shutdown list, detailed into craft sequences, and time is estimated and complied into a master daily schedule by crafts. The shutdown timing is coordinated with the operating departments and required crews hired by the contractors. Shutdown planning is notified of work which is not completed as scheduled or new work arising during the shutdown. This work is fitted into the master schedule for succeeding days where allowances have been made for such occurrences. As shutdown, postshutdown, and any over-accumulation of normal maintenance backlog work is completed, the contractor is requested to reduce his crews.

Controls

All craft time and materials are distributed against job order numbers. These numbers are selected to accumulate charges against specific equipment throughout the refinery. A monthly statement which shows monthly and year-to-date charges against detailed refinery equipment can thus be distributed to the supervisors responsible. A monthly budget-control statement is also distributed, reporting total accumulated monthly job charges compared with the amounts budgeted within areas of operating responsibility.

Other Contractors—In addition to work performed by the general maintenance contractors, numerous other contractors do specialized maintenance and construction work within the refinery. We have had considerable success with small contractors, especially under fixed-cost contracts. These contractors seem best able to give good technical and cost-conscious supervision on the job. Examples of contract work so handled are: tank cleaning, tank car repairs, furnace brickwork, wharf repairs, major painting and insulation, weed control and levee maintenance, and dismantling of facilities.

Conclusion—In conclusion, we have found that the maintenance needs of our two major refineries are most adequately and economically satisfied by a combination of fixed company forces, semipermanent contractor crews, and variable contractor crews. Based upon six years of experience with this maintenance policy, we have found that our widely fluctuating manpower requirements for turnarounds can be adequately satisfied; that our backlog of work is essentially controllable at any predetermined level; that our daily job planning and scheduling can be realistic without influencing new construction work; and that our own company supervisory and craft work forces are stabilized.

In brief, we are convinced that the teamwork of good supervision, stabilized company work forces, job planning and scheduling, plus a variable contractor work force can most effectively and economically handle the peak work requirements of our refinery turnarounds.

Original presentation was at the API Division of Refining midyear meeting, St. Louis, May, 1955. ##

More on Maintenance . . .

Maximum efficiency of the maintenance forces at Gulf Oil Corporation's Port Arthur, Texas, refinery is achieved through advance planning of unit turnarounds and daily scheduling of the working force. For maintenance purposes the refinery is divided into three zones, each covering one of the major departments—light oil, lubricating, and pressure still—and one or more smaller departments. Quarterly schedules of shutdown periods for cleaning and repairs to the major units are prepared each month, reviewed weekly by both operating and maintenance department heads, and revised if necessary. If possible, major unit turnarounds are scheduled to allow a minimum of one week between completion of one and start of another, and minor turnarounds are used to balance the overall maintenance schedule. To facilitate maintenance accounting, each repair is covered by a work order. The maintenance forces are scheduled on a day-to-day basis, except for employees kept on fixed routine maintenance assignments, those in the shops, and the truck and heavy equipment operators. Tools are supplied by one main tool house and two large, fully equipped mobile trailers. ("Scheduling Refinery Maintenance," C. E. Gunter and W. D. Armintor, Gulf Oil Corporation, Port Arthur, Texas.) ##

API Maintenance Session

Maintenance Session

Design for Low Maintenance

Basis of design for low maintenance includes:

- **Use of high-quality equipment of adequate size**
- **Use of minimum number or pieces of equipment**
- **Maximum standardization of equipment**

R. E. Redfield,
Socony-Vacuum Oil Company, Inc.,
New York

THE TOTAL COST of refinery maintenance in this country now exceeds $350,000,000 a year, according to recent estimates. This huge amount lends particular emphasis to the importance of "Planning and Building the Refinery for Minimum Maintenance."

As a first step toward this goal, it is essential to know where and how maintenance dollars are being spent. A study of these costs in several refineries of comparable capacity and production showed very considerable differences, both in total costs and in unit and facility costs. Determination of the reasons for these differences was not an easy task, as can be appreciated. However, two general conclusions were reached, viz.: (1) some variations were the result of efficiency of work planning and performance, and, (2) far greater differences existed in factors which govern the total maintenance work load, such as:

a. The design, layout, quality and adequacy of refinery facilities individually and as a whole, and
b. The total number of pieces of equipment to be maintained.

Since practically all of these factors are fixed in the initial construction, we can conclude that maintenance costs depend to a great extent on the initial selection of equipment and materials, and the manner in which they are installed. Therefore, in order to build for minimum maintenance, the original planning should give full consideration to plant experience, costs, and requirements in the following respects:

1. The use of properly installed high quality equipment and materials, with provisions for effective corrosion and erosion control.
2. Adequate sizing of equipment for capacity requirements.
3. Installation of the least number of facilities and pieces of equipment consistent with good refinery practice.
4. Maximum standardization of equipment.
5. Built-in provisions for efficient maintenance.

The rebuilding of two refineries in France following World War II will be used as an example of how some of these influencing factors were considered.

Of the two refineries in question, one is located on the Seine River in Normandy and had a former capacity of 5,000 barrels per day of crude. It was rebuilt for a capacity of 18,000 barrels per day, which is processed primarily for lubricating-oil production. The lubricating-oil processing units include deasphalting, solvent treating, solvent dewaxing and hot clay contacting.

The second refinery is located near the Mediterranean, in southern France. It had a capacity of 3,500 barrels per day, of crude and was rebuilt to process 25,000 barrels per day for white and black products. It is equipped with catalytic cracking in addition to the other usual facilities.

Both of these refineries were badly damaged by bombing during the war, and in one of them almost all of the processing units were dismantled and shipped into Central Europe during the occupation. Some of this equipment was recovered and reused in the early rebuilding stages.

Toward the end of the war, when private industry started to re-establish itself, there were critical shortages of all construction materials. Equipment manufacturers could not estimate delivery dates with any degree of accuracy. Steel and alloys were stringently allocated and obtainable only in limited amounts.

The short-supply situation in all types of materials led to the establishment of two broad policies, viz.: (1) the equipment installed would be of ample size and of the best quality; and, (2) a minimum amount of material would be used consistent with the projected operations.

These policies were carried out in a number of instances:

Tubular Heat Exchangers—When the rebuilding started, there were no firms in France set up to design and build tubular equipment. Nor was there foreign exchange available to import fabricated units. This led to a decision to design a few basic units adaptable to the various services, which could be readily fabricated from standard materials in the refinery shops or in outside job shops.

Accordingly, three units were designed in approximate sizes of 300, 1000, and 3000 square feet of surface. These were built as required to the extent of more than 450,000 square feet of surface in more than 300 separate units.

The shells corresponded to API pipe sizes in diameters of 16, 26 and 42-in. Standard welding flanges and fittings were used throughout. Most of the units were built for 150-psi operating pressure. For higher ratings, 300-psi and 600-psi flanges and fittings were used, retaining the same basic diameters.

Tube bundles were uniformly standard, using 1 in. 10 gage tubes, 16-ft. long, arranged on a 1¼-in. square pitch. Tube material was predominantly carbon steel or admiralty, with other alloys being used as service conditions required.

Only one tube-bundle design was used in each size, and the tube layout was arranged so that the bundle could be used for either two-pass or four-pass service.

All units in liquid-to-liquid service were built with side-to-side segmental baffles, whereas those in vapor-to-liquid service had deflector baffles.

There were a number of maintenance advantages which resulted from this high-quality standardized construction.

All bundles of the same diameter, pressure rating, and type of service were interchangeable. Turnaround time on operating units was shortened by replacing fouled bundles with clean ones, using a minimum of spare bundles for all units. Fouled bundles could then be cleaned for the next service. In this respect, the 1¼-in. square pitch minimized fouling and made cleaning much easier.

Much can be said in favor of using heavy-gage tubes even though not warranted by operating pressures. There is much less possibility of damage during handling of bundles and during mechanical cleaning. The use of 10-gage tubes in these units has greatly increased the service life, with proportionately lower maintenance costs.

Another great advantage has been the minimum required inventory of spare tubes and gaskets. The standard 1-in. tube is stocked in steel, in admiralty and, to a limited extent, in the other alloys. As for gaskets, there are less than 30 patterns required for the more than 300 units.

Process Pumps—Procurement of process pumps was another serious problem in the initial stages of rebuilding. The time required for delivery ruled out the delaying of orders until specific conditions could be established. An analysis of the projected process and transfer pumping requirements indicated that four different pump sizes, each varied with four or five impellers, could be arranged to cover all the single-stage pumping needs. Accordingly, blanket orders were placed for large numbers of pumps in each size. Altogether, approximately 700 pumps of the same type were ordered from a single French manufacturer. Only a few multistage pumps for specific services had to be imported.

As time went on, the specific operating conditions were developed, at which time the final pump assemblies were made, using the proper type and diameter of impeller for the required service.

The results of this combination of high quality and high degree of standardization have been excellent. The pumps have given good operating service with a minimum of maintenance. When complete preventive-maintenance inspections are due, standardization permits replacement of the entire unit by a spare. Shop overhaul of the pump is efficiently carried out. The quality of maintenance is high because mechanics have become intimately familiar with the standard pump.

Inventories of spare parts can be held to a minimum because of the duplication of sizes, and the possibility of delays because of spare parts availability is greatly reduced.

Some premium was paid for the high quality built into these pumps. However, experience has proved that the high service factor, low maintenance costs, and advantages of standardization have more than justified this premium.

Meet the Author

R. E. REDFIELD, a veteran of 35 years in all phases of petroleum-refining industry, has been associated with Socony-Vacuum Oil Company for 20 years, 15 of which were spent in refinery operations in Europe. Three of his five years with Socony-Vacuum in the U. S. were the result of World War II. He returned to Europe, however, early in 1945 and until 1952, served as general manager of manufacturing in the rebuilding and operating of two refineries in France. He assumed his present position as chief maintenance engineer with Socony-Vacuum when he returned to the U. S. in 1952.

Furnaces—Again in the case of furnaces much thought was given to high-quality standardized construction to reduce maintenance requirements.

Ten furnaces were built in the two refineries. Of these, two in reforming service were identical. Four in atmospheric and vacuum unit service were identical except for the number of radiant tubes. The remainder were designed for specific services.

General design specifications for all furnaces included a maximum of 20 percent excess air, a maximum transfer rate of 8500 Btu per square foot per hour in the radiant section, and 80 to 85 percent, of heat input to the oil in the radiant section.

In the construction of all 10 furnaces only two tube lengths, two tube diameters, and two wall thicknesses were used. Extensive use was made of 5: ½ Chromium-Molybdenum tubes and headers. Tube supports and hangers were high alloy suitable for the service. All firebox linings were first quality refractory encased in steel.

The design limitations have been justified in actual service.

Piping—Following the general policy, it was the intention to make process piping and yard piping as maintenance-free as possible. Special efforts were made to minimize leaks which can be the cause of a large volume of maintenance work.

All yard and transfer piping was installed aboveground on concrete supports, completely welded except for necessary access flanges. The lines were painted to protect against atmospheric corrosion. All valves were steel with alloy trim.

Also, in process areas, piping was designed to be tight, and to facilitate maintenance. Extensive use was made of ring-joint flanges and alloy pipe even in borderline cases. Valves were located so as to be readily accessible for maintenance as well as operation. Piping connections to exchangers and pumps were designed so that maintenance of this equipment involved a minimum of dismantling.

The attention thus given to both yard and unit piping has resulted in reducing maintenance to a minimum. The insistence on tight piping in unit areas has almost eliminated emergency shutdowns caused by oil leaks, and housekeeping has been tremendously improved.

It is not difficult to design and build tight piping if

this is made an objective in the original planning.

Tankage—Storage tanks required the largest steel tonnage in the rebuilding. Recognizing that steel requirements per barrel are progressively lower as tank capacities increase, the problem was given intensive study to arrive at minimum steel use. Tanks were built in the largest sizes consistent with crude-oil and product storage requirements.

Radical reductions were made in the number of rundown and intermediate storage tanks previously thought to be essential. For example, lubricating-oil processes are run on a blocked operation, with all units treating the same stock simultaneously. Using minimum surge tanks between units, this method of operation requires about 200 less unfinished stock tanks than had been used previously. Similarly, minimum-surge tanks were installed in place of rundown tanks between processes in the white and black product operations. In all, about 300 less tanks were installed in the two refineries than had previously been considered necessary.

With the great reduction in number of tanks, there was a corresponding reduction in pumps, piping, heating, and fire-protection facilities, all of which require maintenance as well as the tanks. This is a prime example of approaching minimum maintenance by installation of the minimum number of pieces of equipment.

Steam Generation and Distribution—In rebuilding the refineries, efforts were directed toward maximum use of electric drives and minimum distribution and use of steam.

In the Normandy plant steam generation averages 140-pounds per barrel of crude charge, with complete electrical generation. Sixty-five percent of the condensate is recovered.

Steam at 150-psi is extracted from the generator turbines for plant distribution. By necessity, some steam driven equipment was reused, and this exhausts to a 20-psi pressure system used for processing and tank heating.

The former extensive steam loop system was replaced by minimum size dead-end lines running to steam consumption points.

In the Mediterranean refinery, steam generation is at a minimum, averaging 40 pounds per barrel of crude charge, with complete electrical generation. Special attention had to be given to steam consumption and condensate recovery because only 90 gallons per minute of fresh water for boiler feed are available. As a result, the plant is completely electrified except for four steam-driven standby pumps in critical services.

Only 150-psi pressure extraction steam from the generator turbines is distributed in the refinery for general processing and tank heating. The distribution system consists of 800 feet of 6-inch and 2000 feet of 3-inch main lines. There is no exhaust steam system.

The volume of maintenance work normally arising from extensive use of steam-driven equipment and the associated multipressure distribution networks does not exist in this refinery. Maintenance expense for steam generation and distribution has been a negligible item.

Conclusion—The instances just cited are only a few examples of building for minimum maintenance. They have dealt primarily with the use of corrosion-resistant materials, and with adequate, standardized, minimum installation of equipment. Similar examples could be cited showing the importance of proper design and layout and built-in work aids. Much more could be said of how provision for effective corrosion and erosion control in the initial planning can drastically reduce maintenance costs.

Minimum maintenance should be recognized as one of the primary objectives in the initial planning of refinery facilities. A great forward step will have been taken when design, selection, and arrangement of equipment is guided by appreciation of maintenance costs as well as by initial capital investment.

Refinery facilities planned and built in this manner will be well designed, and will use standardized high-quality equipment and materials. The equipment will be adequately sized, installed in the minimum number of pieces, and with built-in provisions for corrosion control. Such facilities will truly require minimum maintenance, which will be reflected in high operating factors and greater over-all refinery benefits.

Original presentation was at the API Division of Refining midyear meeting, St. Louis, May, 1955. ##

Does Standardization Pay?

Alloy-steel pipe, flanges and welding fittings offer three possibilities of savings in dollars and time through standardization coordinated between operating, research, storehouse, engineering, and purchasing departments.

In addition to the monetary savings resulting from proper standardization, there are other benefits which will be realized. One is the fact that a mechanic can service the equipment made by a *few* manufacturers, but may be lost when required to be an expert on equipment furnished by *many* manufacturers. It is also believed that inventories tend to rise in proportion to the number of manufacturers involved and, to a lesser extent, in proportion to the variations of styles and sizes. Standard materials generally are readily available.

The possible advantages of standardization on valves manufactured by a limited number of companies and a basic alloy for valve trim should be considered. By confining the list of approved manufacturers to a reasonable number, the advantages of competitive bidding can be furthered, because the volume of business to a given supplier may be increased to such an extent that the manufacturer will have an added incentive for more efficient and profitable operation. In addition, the interchangeability of spare parts can be exploited to a maximum, and availability of replacement parts will not be a problem. Minimum inventories of valves and their component parts can be maintained.

A table and illustrations showing the relation between the quantity of an order and the price for various chrome nickel and straight chrome alloy piping, flanges, and welding fittings were presented. The advantages of standardization presents interesting possibilities for the user to order alloy material in reasonable basic quantities.

Pump standardization also has potential value. ("The Effect of Standardization on Maintenance," Haylett O'Neill, Jr., Humble Oil & Refining Company, Houston.)

Fuel & Lubricants Session

Needed: A New Knock-Test Unit

ASTM is working to improve precision of knock testing; but work load will be tremendous to obtain significant improvements in two or three years.

M. R. Morrow,
Humble Oil & Refining Company,
Baytown, Texas

SIGNIFICANT IMPROVEMENTS in the precision of laboratory knock-test methods could reduce the cost of motor gasoline produced in the United States by $12 million per year. Half of this saving can be realized by multiple testing to improve the precision of results. However, significant improvements in the test methods are necessary to obtain the remaining $6 million per year. Customer complaints caused by wide variations in the quality of the produce would be reduced or eliminated, and at least a part of the foregoing saving could be passed on to the customer.

A previous discussion[1] of this general subject dealt with the economic credits for improving the precision of critical tests through multiple testing of finished products. By critical tests is meant those test results which significantly affect the cost or producible volume of the product involved. Experience gained in the application of this technique has shown that, although substantial credits can be realized, practical considerations limit credits to considerably less than the total which could be realized with perfect test methods. These factors usually involve time; i.e., limited tankage to hold blends in tankage while testing, limited time to meet cargo commitments, and similar factors. Consequently, it has become evident that further savings can be realized by improving the precision of critical test methods. This discussion presents the justification for such work from the refining, marketing, and consumer viewpoints. For illustration, the most critical test methods employed in refining—viz., knock testing of aviation and motor gasolines—are considered, and a brief discussion is presented of recommendations made to ASTM, aimed at developing a new or significantly improved knock-test unit or units.

Gasoline Blending, Testing, and Acceptance

A discussion* of these factors and their effect on product quality and costs indicates the following:

In the preparation of blends various errors occur. The resultant variations in true quality can be represented by a standard deviation of blending, σ_B. To prevent excessive rejection rates on testing, blends are prepared to meet a target quality above specification. In the testing of blends various errors also occur. The magnitude of these variations can be represented by a standard deviation of testing, σ_T. The precision of test results can be improved by multiple testing and the use of average results. The improvement is a function of the square root of the number of tests; i.e., an increase in tests from 1 to 4 would reduce a σ_T value of 0.4 to 0.2.

Because of the normal variations discussed in the preceding paragraph, some product which is below specification in true quality is accepted by test. Inasmuch as these blends cause complaints in many cases, specifications are increased over actual needs to include a deliberate safety factor or an "experience" factor. The lower quality actually needed has been arbitrarily designated minimum field requirement (mfr). Rigorous definition of mfr is difficult but, theoretically, product below mfr in true quality will cause serious field complaints. In other words, material below specification in true quality but accepted by test is undesirable, but does not cause difficulties unless the true quality is below mfr.

Incentives for the Refiner

A. *Motor Gasoline*—While blending and testing techniques were being developed in the 1930's, σ_B and σ_T values for the octane quality probably were about 1.0 and 0.8,

* Appendix I to the original presentation outlined in detail the relationships involved in gasoline blending, testing, and acceptance.

Meet the Author

MORRIS R. MORROW has been with Humble Oil & Refining Company since he left the University of Texas in 1940 with a master's degree in chemical engineering. Now a research specialist at the Baytown, Texas, refinery, his assignments have covered all phases of petroleum processing for the production of aviation and motor fuels, specialty solvents and naphthas, and middle distillates. He has a broad background in factors influencing the quality and performance of finished products, and recently has become active in the application of statistical procedures to refinery problems.

respectively. With these high values, material accepted by test but below specification in true octane quality could be as high as 25 percent. In such cases complaints on quality of the product probably were frequent. To lessen complaints by reducing the amount from 25 percent to 5 percent requires a higher average (target) quality of blends.

Through the years, blending operations have been improved, and σ_B values are now believed to be about 0.5 octane number in most cases. Similarly, testing precision, σ_T, has been improved steadily through the years and is now believed to be about 0.4 octane number in most cases.

As mentioned, σ_T can be reduced to 0.2 by quadruplicate testing. However, for the future it would be desirable to have a test method with significantly higher precision. As a goal, a σ_T value of 0.1 has been arbitrarily selected.

Using the methods developed in the previous article,[1] the cost of refinery reblending, refinery testing, and product octane-quality giveaway above specifications have been calculated for the various combinations of σ_B, σ_T, and percent of material accepted by test, but below specification in the true quality as discussed hereinbefore. These costs were based on reasonable but assumed values. The product octane-quality giveaway costs were based on octane improvement using tetraethyllead and, therefore, represent essentially minimum costs for product-quality giveaway. The results of these calculations are shown in Table 1.

Case I represents early operations as discussed hereinbefore, and a cost of $26 per 1000 barrels is indicated. To reduce to 5 percent the 25 percent of material below specification accepted by test requires an increase in average quality, and results in an increase in cost to $61 per 1000 barrels, as shown for Case II, For Case II and all subsequent cases, the material below specification accepted by test is held constant at 5 percent.

The high costs and/or complaints involved in Cases I and II provided the incentives for improvements as represented by Cases III and IV. In Case III costs are reduced to $47 per 1000 barrels by reducing σ_T from 0.8 to 0.4, and in Case IV costs are reduced further to $31 per 1000 barrels by the reduction in σ_B from 1.0 and 0.5.

Case IV represents the approximate general situation in the U. S. today. The $31 per 1000 barrels product costs represent an overall cost of $28 million per year, based on 2.5 million barrels of gasoline produced per day in the United States. These costs—for reblending, testing, and product-quality giveaway—are made necessary only because of blending and testing errors.

Further reductions in these costs can be realized by improvement in knock-test methods. If the future goal of 0.1 for σ_T can be realized, the current costs of $28 million per year (Case IV) could be reduced to $16 million per year, as shown by Case VI. However, half of this $12 million saving per year can be obtained by multitesting to reduce the present σ_T value from 0.4 to 0.2, as shown by Case V.

The remaining $6 million saving per year represented by Case VI over Case V applies directly to work aimed at improving knock testing to a σ_T level of 0.1. Actually the credits will be even larger because knock testing errors in the testing of components enter into σ_B values, as employed in this study. Thus some additional savings would result from the improvement in overall σ_B values.

B. *Aviation Gasoline*—Incentives of the same general magnitude (in dollars per 1000 barrels) are known to exist for improvements in the precision of testing aviation fuels. These credits also will be realized because improvements in octane testing results by the Research and Motor methods probably can be applied also to testing by the Aviation and Supercharge-rich methods.

Incentives for the Customer

A. *Motor Gasoline*—Each of the motor-gasoline cases discussed above involves shipment of accepted product to marketers for sale to the ultimate consumer. For these cases the variations in true quality of the product purchased by the consumer are as shown in Figure 1. Shown is an assumed specification of 95.0 octane number, an mfr estimated to be 94.5, and a target quality which varies.

TABLE 1

Effect of Blending Precision σ_B, Testing Precision, σ_T, and Quality of Material Accepted on Product Costs

Case:	I	II	III	IV	V	VI
				Current		
Probable Period in Effect:	1930's			Single Testing	Multiple Testing	Desired in Future
Blending precision, σ_B	1.0	1.0	1.0	0.5	0.5	0.5
Testing precision, σ_T	0.8	0.8	0.4	0.4	0.2	0.1
Blends accepted by test which are actually below specification in true quality, percent	25	5	5	5	5	5
Product reblending, testing and quality giveaway costs:*						
In dollars per 1,000 bbl.	26	61	47	31	24	18
In thousand dollars per calendar day for the United States†	..	..	..	78	60	45
In million dollars per year for the United States†	..	..	..	28	22	16

* The methods employed to obtain these costs were discussed in the previous article mentioned in the introduction.
† Assuming production of 2,500,000 bbl. of motor gasoline per calendar day.

The target is held as close to specification as possible while holding constant the percent of material accepted by test which is actually below specification in true quality. For Case I the percent accepted is 25, but for all other cases the percent acccepted is 5. With the foregoing restrictions, the target is then governed by the blending and testing precisions.

For Cases I and II—representing operations in the 1930's—the relatively poor blending precision ($\sigma_B = 1.0$) and poor testing precision ($\sigma_T = 0.8$) resulted in wide variations in true quality of accepted product as shown. If costs are held down by lowering the target (Case I), field complaints occur because of the frequent sales of product below mfr quality. If the target quality is raised to eliminate acceptance of material below mfr in quality, costs are increased significantly. Further, the wide variations in quality can result in complaints from customers who notice and like the high-quality material which they receive only part of the time.

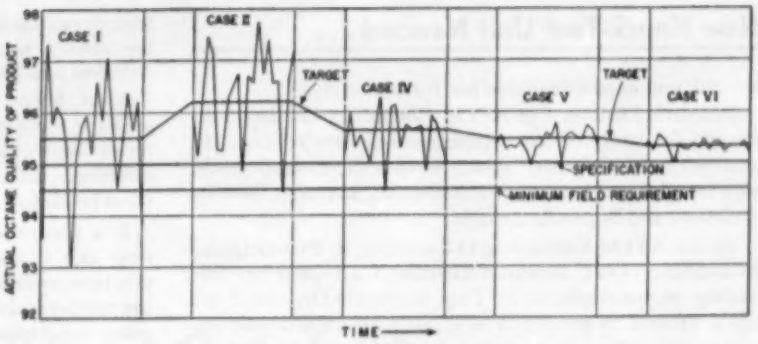

FIGURE 1—Variations in quality of blends accepted by test.

The current refinery situation represented by Case IV has been made possible by improvements in blending precision ($\sigma_B = 0.5$) and testing precision ($\sigma_T = 0.4$). This has reduced costs, but customer approval is not significantly improved compared to Case II. Blends below mfr in quality are still accepted by test occasionally, and complaints are registered.

Multiple (quadruplicate) testing, as represented by Case V with σ_T reduced to 0.2, does have direct customer benefits. In this case product below mfr is no longer accepted by test. In other words, material accepted by test but below specification in true quality still amounts to 5 percent, but the average and minimum quality of such material is raised closer to specification.

In the early discussions of the merits of reducing costs through multitesting, the question was raised as to whether the savings were not merely a reflection of lower-quality product being sold. Sales and marketing representatives studied the proposal and were strongly in favor of initiating multiple testing. Their two major comments were as follows:

1. Reductions in variations in quality from blend to blend, made possible by more precise testing, are very desirable because product complaints were indicated to be intermittent and epidemic in nature. This pointed strongly to occasional blends being accepted by test which were below mfr in true quality.

2. In setting specifications for purchase of a product, the intent is to get exactly what is requested. If higher quality is needed, it can be specified. The higher costs and variations in quality associated with poor test precision offset any advantages for the slightly higher average quality.

For the consumer of motor gasoline, the benefits for improving test precision beyond Case V ($\sigma_T = 0.2$) are minor unless part of the refinery savings are passed on as lower prices. This has occurred historically in the refining business, and probably will occur in this case.

B. *Aviation Gasoline*—Specifications for octane quality of aviation fuels are fixed to assure satisfactory field performance. They are known to contain safety factors and, therefore, an mfr exists below current requirements. Detailed analyses of current test precisions have not been carried out. However, from available studies it is believed that an improvement in precision of Aviation-method and Supercharge-rich-method test results, comparable to the improvement in motor gasoline testing discussed hereinbefore (σ_T reduced from 0.4 to 0.1) would allow an increase in production of about 10 percent, particularly of grade 115/145. The resultant reduction in blend quality variations also might permit a reduction in specification qualities closer to mfr. In other words, grade 115/145 might become grade 110/140, etc. In this case costs would be reduced, and maximum production rates increased.

Specification Considerations

Specifications for petroleum products in almost all cases are set without regard for the precision of the control tests employed. However, statistical quality-control methods are being adopted in refinery operations at a fairly rapid rate. As soon as a background of statistical experience is generally available, it will be possible to rewrite specifications to provide more exact control. Their form will be simple. They will require: (1) a specified quality; and (2) a guarantee that no more than a small fixed percentage of blends accepted by test are below specified quality.

Such specifications will make it necessary for each refiner to establish what his situation is with respect to σ_B and σ_T as discussed herein. They also will reduce customer complaints and permit savings as discussed herein as soon as improved test methods have been provided.

Work with the American Society for Testing Materials

The problem of knock testing of aviation gasolines was studied in 1952 and 1953 by the Armed Services-Industry Cooperative Group on Fuel Rating. The need for improved knock testing of aviation fuels was recognized, and the American Society for Testing Materials was asked to sponsor an investigation aimed at improvements in laboratory knock-test methods for aviation-gasoline evaluations. A new approach to knock testing involving the temperature and density of end gases during combustion was con-

API Fuel & Lubricants Session

New Knock-Test Unit Needed . . .

sidered and made available for further study.

Research Division I of ASTM Committee D-2 has continued the study of the temperature-density concept. If successful, this approach could provide the desired precision on all four knock-test methods, viz., Research, Motor, Aviation, and Supercharge rich.

At the ASTM Committee D-2 meeting in Philadelphia, in February 1954, Research Division I accepted the following recommendation: "That Research Division I set up a project to develop a new basic knock test unit incorporating all current engineering and knock test knowledge." The recommendation was made by representatives of Humble Oil & Refining Company. Following the meeting, a proposed program was prepared by Humble and submitted to Research Division I for consideration. Specific mechanical changes were suggested, as shown in Appendix II.

To integrate this work with ASTM studies of the temperature-density concept, it was assumed that Sect. F (Test Method Development) of Research Division I would handle the problem. The following specific steps were suggested:

1. That ASTM regional knock-test groups discuss the attached Appendix II and recommend additions, deletions, and modifications to the program.
2. That Sect. F request the National Advisory Council for Aeronautics, car manufacturers, and other groups active in the field of combustion to review the proposed program from a fundamental standpoint and recommend items for consideration.
3. That members of Research Division I request comments and advice from their own staff and consultants on the problem.
4. That Sect. F, after receipt of information from the foregoing items 1 to 3, arrange for a 4- or 8-hour session at an ASTM Committee D-2 meeting to reach agreement on specific engine changes to be attempted.
5. That Sect. F obtain from Waukesha Motor Company and/or others an estimate of the cost of building one or more prototype engines.

At this point, ASTM work on the temperature-end-gas density approach to elimination of variations in knock-test results should have progressed sufficiently to permit consideration of making the engine do all four types of knock rating (Research, Motor, Aviation, and Supercharge rich). Depending upon results of that work, the program might have to be modified. Assuming that the two programs could be integrated, the following steps would be appropriate:

6. That one or more of the engines should be built, and the regular ASTM procedures of evaluation initiated.
7. That, if at all possible, 8 or 10 engines should be built. Those groups which receive them for evaluation should place each one in regular service as a unit to rate selected refinery control samples. In this manner, operating experience could be obtained on samples whenever minor differences between the results and regular Research-method or Motor-method octane results are not critical. This period of routine use appears essential in order to avoid usual early inaccuracies resulting from inexperience with the unit. If this procedure had been followed on the Armed Services-Industry Cooperative Group on Fuel Rating evaluation of the DCC-6 engine, it is possible that the results would have warranted replacement of the Aviation and Supercharge-rich methods.

As of January 1955 Research Division I had not initiated the foregoing suggestions. Several Gulf Coast laboratories have ordered demountable knock-test heads (split cylinders), as discussed in Appendix II*. Evaluation of these heads will be initiated in 1955.

It is presumed that ASTM will initiate work on a basic new unit if and when it is established that the desired precision cannot be obtained with present engines using the temperature-density concept. As indicated by the foregoing suggestions, the problem will be difficult and time consuming. Consequently, the work load in Research Division I will be considerably higher than normal while this problem is under study.

Original presentation was before the API Division of Refining meeting, St. Louis, May 11, 1955.

ACKNOWLEDGMENT

The author is grateful to the Humble Oil & Refining Company for permission to publish this paper, and to his associates for their advice and assistance in its preparation.

LITERATURE CITED

[1] M. R. Morrow and C. T. Shewell, "Effect of Multitesting on Refinery Production Costs," Ind. Eng. Chem. 45 (1) 240-6 (1953).

* The Appendix II to the original presentation outlined in detail the specific mechanical changes suggested.

More on Fuels and Lubricants . . .

The ignition delays and minimum ignition temperatures of numerous pure hydrocarbons were determined in a constant-volume bomb at 250 and 650 psig, at 8 temperatures between 500 F. and 1390 F. Ignition-delay measurements were also made on 2 secondary diesel reference fuels. At low bomb temperatures, ignition delay decreased with increasing fuel-air ratio toward stoichiometric, but at higher temperatures it increased. Increased pressure shortened ignition delay above 800 F., but increased it for many fuels at temperatures approaching the minimum for autoignition. Ignition delay usually decreased with increasing temperature, but this behavior varied widely for different hydrocarbon structures. The relative ease of ignition of *iso*octane and cyclohexane varied with temperature. Branched-chain hydrocarbon fuels apparently were less temperature-sensitive than paraffins or naphthenes. Ignition delay decreased with increasing chain length (paraffins, olefins, and alkylnaphthenes), or on addition of a methyl group to a naphthene or saturation of an olefinic bond. It increased markedly as the degree of branching increased. The effects of structural changes varied markedly with test conditions. The ignition delays of triptane and *iso*octane increased with temperature between fairly narrow limits. With some exceptions, the minimum ignition temperatures were in the relative order to be expected from ignition-delay data. A unique correlation of cetane number with ignition-delay measurements for fuels of widely varying structure could not be obtained. The various fuels differed markedly in their rates of heat release. ("Autoignition of Fuels in a Constant-Volume Bomb: Effects of Operating Variables and Fuel Structure," M. A. Elliott, Illinois Institute of Technology, Chicago; R. W. Hurn, Bureau of Mines, Bartlesville; and H. M. Trimble, Phillips Petroleum Company, Bartlesville, Okla.) ##

Research Dwells on Catalyst Poisons

Nickel and Vanadium: There is still need in the petroleum industry for a rapid and reliable method for the determination of traces of nickel and vanadium in petroleum products.

A new catalytic ashing procedure has been developed. The oil is charred with a solid catalyst which will act also as a spectrographic collector of the metals. The nickel and vanadium are uniformly spread on the surface of this collector in such a way that fairly accurate determinations are still possible with 5 micrograms of these metals. By using the catalytic ashing method, accurate results can be obtained with oils containing 10 ppm of nickel and vanadium, using only 2 grams of sample. The complete analysis can be performed in less than 6 hours. ("Spectrographic Determination of Nickel and Vanadium in Petroleum Products by Catalytic Ashing," A. L. Juliard, J. E. McEvoy and T. H. Milliken, Houdry Process Corporation, Marcus, Hook, Pa.)

An X-ray spectrographic method has also been developed for the determination of nickel and vanadium in trace quantities. The method is fast, requires in most cases no more than 20 grams of sample, and is comparable with other methods in accuracy. A sample to be analyzed is first ashed, and the ash put in solution. A portion of this solution is evaporated on a sample plate and rotated under an X-ray beam. The intensity of the fluorescent radiation from the sample which is a function of the metal concentration, is determined. Iron is the only element normally present which offers any interference. A procedure was described for the removal of iron when it is present in sufficient concentration to give interference. ("An X-ray Spectrographic Method for the Determination of Vanadium and Nickel in Residual Fuels and Charging Stocks," E. N. Davis and Barbara C. Hoeck, Sinclair Research Laboratories, Harvey, Ill.)

Other Trace Metals: Trace metals in petroleum, in the form of complex organometallic compounds, range from the more common ones such as iron, copper, zinc, and lead to rare and precious ones such as silver, gold, and even uranium.

These authors reported a method for the identification of about 20 of these metals by burning a tablespoonful of oil in a flame spectrophotometer and measuring the wavelength of the light formed by the burning metals in the oil. ("Flame Spectra of 20 Metals Using a Recording Flame Spectrophotometer," M. Whisman and B. H. Eccleston, Petroleum Experiment Station, Bureau of Mines, Bartlesville, Okla.)

During their study of methods of removing these metals Humble scientists have also devised a means of analysis of these metals which is superior to older methods of analysis. ("Determination of Trace Metals in Oils," J. T. Horeczy, B. N. Hill, A. E. Walters and H. G. Schutze, Humble Oil & Refining Company, Baytown, Texas; W. H. Bonner, E. I. du Pont de Nemours and Company, Wilmington, Del.)

Total Nitrogen: The presence of even trace quantities of nitrogen compounds in feed stocks can seriously reduce the activity of platinum catalysts.

A nitrogen method previously studied by the API Committee on Analytical Research has been modified for the analysis of light petroleum distillates. It is suitable for the concentration range from 1 ppm to 100 ppm. The method involves conversion of nitrogen compounds to ammonia by catalytic hydrogenation. The ammonia is then determined colorimetrically. Data on a number of synthetic blends show that the sensitivity and accuracy are about 1 ppm of nitrogen. The equipment required is relatively inexpensive, simple to operate, and easy to maintain. The procedure is well suited for routine work, and is readily adaptable to multiple determinations. Samples containing as little as 1 ppm to 2 ppm of nitrogen may be accurately analyzed in a little less than 2 hours. ("The Determination of Total Nitrogen in Reformer Charge Stock," R. W. King and W. B. M. Faulconer, Research and Development Department, Sun Oil Company, Norwood, Pa.)

The analytical determination of many elements present in crude petroleum or its fractions at low concentrations usually imposes certain practical limitations in their use for control or routine purposes. In an effort to improve this situation with regard to total nitrogen and basic

nitrogen determinations, a study was initiated to find out if procedures could be developed which might overcome, at least in part, the disadvantages of the methods currently recommended. The method described for total nitrogen appears to be suitable for multiple determination of amounts as low as 2 ppm nitrogen with the use of conventional equipment. The proposed basic nitrogen procedure has likewise been extended to the 1 ppm to 2 ppm level without sacrificing speed or simplicity. ("Trace Amounts of Total and Basic Nitrogen in Petroleum Distillates," R. E. Snyder, D. T. Fanale, R. B. Fricioni, D. W. Hutton and R. O. Clark, Gulf Research and Development Company, Pittsburgh.)

Carbonyl Sulfide: Quantitative determination of carbonyl sulfide in petroleum refinery gases is now made possible by a rapid spectrophotometric method. Carbonyl sulfide is completely extracted from a carrier gas with an aqueous piperidine solution, and is quantitatively determined by the absorption of ultraviolet at 230 millimicrons.

This new, speedy method is performed without any interference from hydrogen, oxygen, nitrogen, carbon monoxide, methane, ethane, acetylene, ethylene, propane, and propylene. However, interferences do result from the presence of hydrogen sulfide, mercaptans, carbon dioxide, sulfur dioxide, carbondisulfide, thiophene, and conjugated diolefins. These interfering components may be divided into two groups, viz., compounds which are eliminated by scrubbing and compounds which are corrected by application of a "blank" run. ("The Spectrophotometric Determination of Carbonyl Sulfide in Petroleum Refinery Gases," H. W. Fleming, F. J. O'Hara and W. M. Keely, The Girdler Company, Louisville, Ky.)

Punched Cards: Operation of an industrial analytical laboratory may be considered analogous to that of a business offering a service as its product. As such, it must provide accurate, precise analyses as to quality merchandise; give service consistent with the needs of the operating units and research groups which comprise its customers; and provide these services in an efficient, economical manner. These aims can be greatly facilitated by the use of a punched-card system utilizing standard card-handling and accounting machines. This paper described the adaptation of an inventory control procedure which handles mechanically all sample identification, test scheduling, and data reporting in an analytical laboratory. An important benefit provided by the system is a wealth of control information concerning productivity, cost distribution, backlog, and work load. This has resulted in improved service to the customers, fewer errors, higher laboratory productivity, and lower overhead costs. ("Analytical Laboratory Operation and Control Utilizing Business-Machine Punched-Card Procedures," L. M. Addison, E. H. Spencer and E. M. Charlet, Esso Laboratories, Esso Standard Oil Company, Baton Rouge, La.)

Lube Oil Composition: With modern research tools for the separation and analysis of petroleum stocks, it is now possible to shed new light on the composition of lubricating oil and on the chemical structure of these heavy molecules. In this investigation a medium-viscosity lubricating-oil stock was separated into many fractions by means of thermal diffusion, adsorption, and molecular distillation. There fractions ranged in viscosity index from far above to far below the level of commercial motor oil. Each fraction was then examined by the latest analytical methods—including ultraviolet, infrared, and mass spectrometry—which are capable of detecting significant differences in the structures of the molecules. For the first time data were obtained to show that lubricating oil contains molecules which have up to 10 ring structures in their makeup. ("A New Look at the Composition of Lubricating Oil," F. W. Melpolder, R. A. Brown, T. A. Washall, W. Doherty and C. E. Headington, The Atlantic Refining Company, Philadelphia.)

Infrared: Successful fractionation of saturated olefin-free petroleum to obtain specific hydrocarbons for the production of specialty solvents, chemical and plastic intermediates, is dependent among other things upon rapid and accurate methods of analyses. The complexity of the problem increases with an increase in boiling point of the material desired. Most physical or chemical methods of analyses are either incapable of making the necessary determinations, or they consume too much time to be of practical benefit. A new infrared method has been developed by which many such determinations may be made quickly and accurately.

In this procedure a characteristic absorption at some selected wavelength is measured against the absorption produced by a standard contained in a reference cell. The interfering effects of the compounds present in the sample are materially reduced or canceled by alternately passing the beam of light through the reference cell and the sample cell. The material contained in the reference cell is composed of a base material or calibration standard similar to the sample, except that the key component is known and is generally a few per cent less than that expected in the sample. By measuring the degree of absorption obtained from a series of standards and comparing them with the unknown sample, the concentration of the desired component may be easily calculated. The determinations are made in a double-beam infrared spectrophotometer. ("A Differential Infrared Method for Quantitatively Determining Specific Hydrocarbons," C. W. Key and Orland Eastin, Richfield Oil Corporation, Los Angeles.)

Naphthenic Hydrocarbons: Twelve laboratories have compared their methods for determining the six and seven carbon naphthenes in a California naphthenic charge stock. These naphthenes are the precursors of benzene and toluene. Excellent agreement was obtained among the methods, including mass spectrometry, infrared spectrometry, refractivity intercept, and catalytic dehydrogenation. Standard hydrocarbon samples and physical data supplied by API fundamental research projects have played an important part in the development and testing of these methods. ("Determination of Six and Seven Carbon Naphthenes in Reformer Charge Stock,"

C. C. Martin and S. S. Kurtz, Jr., Sun Oil Company, Marcus Hook, Pa.)

Oxygen in Gases: The sodium anthroquinone-B-sulfonate colorimetric method has been successfully applied to the determination of from 0 ppm to 50 ppm of oxygen in hydrocarbon gases, with an accuracy of ±6 percent. Nitrogen, hydrogen, carbon dioxide, and acetylene do not interfere. Carbon monoxide does, however interfere if present in large amounts. The apparatus is simple and inexpensive, and can be made portable. Six samples can be analyzed by this method in one day. The method is adaptable to continuous, automatic instrumentation. ("Colorimetric Determination of Low Concentrations of Oxygen In Gases," C. Stafford, J. E. Puckett, M. D. Grimes and B. J. Heinrich, Phillips Petroleum Company, Bartlesville, Okla.)

Evaporation Losses: Two laboratory methods have been developed for the accurate determination of evaporation losses in refinery petroleum tanks. The first procedure is a modified Chenicek-Whitman vapor-pressure method. A measured amount of dry air is bubbled through a known amount of the hydrocarbon mixture at a fixed temperature and at a rate to insure saturation of the air with hydrocarbon vapors. The vapor pressure of the hydrocarbon mixture is calculated from the volume of the vapor evolved, the total amount of air and vapor, and the pressure of the gas-measuring device. The decreased in liquid volume is measured directly. The vapor pressure is determined for successive increments of sample evaporated until 3 to 5 percent of the sample has been evaporated. The vapor-pressure-evaporation curves of the original and depleted samples are plotted on the same scale, and the horizontal distance between the curves represents the loss incurred. The procedure has good reproducibility and can accurately detect losses as low as 0.04 percent. It can be applied to practically any type of problem involving evaporation.

The second procedure is a density method which is capable of determining evaporation losses as low as 0.01 percent. This method is intended for the accurate measurement of density and evaporation loss of any hydrocarbon mixture which can be handled in a normal fashion as a liquid, and is not applicable to highly volatile liquids (vapor pressure, 0.9 atmosphere or higher) or extremely viscous liquids. The report describes the apparatus and method required for establishing a density-evaporation curve which is necessary to determine the effect of the evaporation loss on the density of the sample under investigation. The density-evaporation curve is obtained by plotting the densities against the per cent by volume evaporated. Evaporation losses on depleted samples of the original material are obtained by determining the densities of the depleted samples and reading directly the evaporation loss from the density-evaporation curve of the original material. The method is accurate and convenient, and is applicable to almost any type of evaporation problem. The procedure shows good results. ("Laboratory Methods for the Determination of Evaporation Losses of Petroleum Products," J. Holowchak and E. L. Baldeschwieler, Esso Research Engineering Company, Linden, N. J.)

Elemental Sulfur: The economics of desulfurization processes have indicated a need for a dependable procedure for determination of the elemental sulfur content both before and after treatment for its removal. A polarographic procedure has been developed using a solvent-electrolyte system of prolonged stability, high sensitivity, and in which even the asphaltic sludge from crude oil appears to be soluble. Data obtained with samples of crude oil and certain petroleum fractions show very satisfactory reproducibility. The procedure should be adaptable to the determination of elemental sulfur in petroleum distillates, thermal diffusion fractions, etc., as well as to crude oil. ("The Polarographic Determination of Elemental Sulfur in Crude Petroleum Oil and Its Fractions," H. V. Drushel and J. F. Miller, Mellon Institute of Industrial Research; Ralph O. Clark and Walter Hubis, Gulf Research and Development Company, Pittsburgh.)

Miniature Columns: Performance data for miniature distillation columns are needed to select the best column and operating conditions for separating a particular sample. Columns must be evaluated under both total reflux and actual operating conditions. Such a study has been made of three commercially available columns.

A total reflux, the Hyper-Cal has a lower heat-efficiency throughput than concentric-tube and spinning-band columns. The spinning-band column has the lowest holdup and pressure drop; it is more efficient when a tight band is used and rotated at the optimum speed. Reducing pressure to 300 mm decreases plates for all columns at moderate but not at low throughput. Studies at partial reflux reveal the importance of holdup. Within a narrow range of sample size, a spinning-band column can give a better separation than a Hyper-Cal having more plates. With small samples, high reflux ratio is undesirable. Equivalent separations have been obtained in both miniature and macro Hyper-Cal columns operated under like conditions. ("Analytical Distillation in Miniature Columns—II: Performance under Total and Partial Reflux," A. G. Nerheim and R. A. Dinerstein, Research Department, Standard Oil Company (Indiana), Whiting.)

Pressure Vessel Session Sees New Horizons . . .

Codes Need to be Revised for New Materials: Code requirements for pressure vessels are presently associated with extremely ductile materials and safety factors sufficient to limit consideration to principal stresses evaluated by simple formulas. Advances in physics have extended present knowledge of fundamental behavior, and metallurgical progress has provided new, improved, and special-purpose materials. The horizons of both analytical and experimental stress analysis have been vastly extended; and new and improved inspection techniques and equipment are available. The trend toward balanced or adequately proportioned pressure vessels is accentuated further by new critical materials whose greatly increased

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cost justifies the objective of higher working stresses as obtained from such factors as improved design and fabrication. This discussion indicated principles for revision of the pressure-vessel codes to a broader base so that they will suit the wide variations in service and economic demands. ("Considerations Affecting More Economic But Equally Safe Pressure-Vessel Construction Utilizing Either Present-Day Ductile Materials or New High-Strength Less-Ductile Materials," J. J. Murphy, C. R. Soderberg, Jr., and D. B. Rossheim, The M. W. Kellogg Company, New York.)

Weldability: The properties of low-alloy high-strength steels compare favorably with those of carbon steel for use in pressure vessels. In addition, it is possible to use higher design stresses and thus affect savings in weight and cost. The API Pressure Vessel Research Committee selected six high-strength steels representing three strength levels for extensive mechanical tests in order to determine their suitability for use in pressure vessels with increased design stresses. The six steels were compared on the basis of room- and elevated-temperature tension tests, notch-toughness unwelded and welded, plastic fatigue, and standard weld qualification tests. Within the limits of usefulness characteristic of laborator type testing methods, the tests indicate that the properties of the steels are favorable to their further consideration for application to pressure vessels of increased design stresses. ("Mechanical Properties and Weldability of Six High-Strength Steels Applicable to Pressure Vessels," R. D. Stout and J. H. Gross, Lehigh University, Bethlehem, Pa.)

Graphitization: This report by the API Subgroup on Deterioration of Steels at High Temperature summarizes information which has resulted from the subgroup's investigation of the extent and causes of graphitization of steel in petroleum refining equipment. It is a compilation of laboratory analyses of specimens of steel which had been removed from the operating equipment of refiners participating in the test program. Significant trends, which appear to be the result of the application of certain materials and under certain service conditions, are pointed out; and some recommendations are made which have developed as a natural outgrowth of this work. ("Graphitization of Steel in Petroleum Refining Equipment," J. G. Wilson, Shell Oil Company, New York.)

Smokes and Fumes Session Points at Ozone . . .

Los Angeles Was the First Described: Stanford Research Institute has been studying the mechanism of ozone formation in atmospheres which contain the combustion products of petroleum. The importance of ozone formation lies in its ability to react with automobile exhaust, under realistic concentration conditions, to produce the so-called smog damage on plants. This plant damage has been observed in other urban areas, as well as in the Los Angeles area where it was first described. The formation of ozone in polluted atmospheres has been shown to be photochemical in nature and produced by light in the 3,000-Å to 4,000-Å region. ("The Formation of Ozone in Polluted Atmospheres," L. M Richards, Stanford Research Institute, Stanford, Calif.)

Survey of Cities: Investigation of the concentration of ozone in 10 representative American cities showed that the levels of concentration of oxidant which in the atmosphere varied inversely with the concentration of sulfur dioxide which was present. The concentration of oxidant was generally so low as not to lend itself to correlation with meteorologic variables. The relatively high levels of concentration of oxidant which have been found in Los Angeles during periods of fog and inversion were not encountered in the cities investigated. ("The Concentration of Ozone in the Atmosphere of Certain American Cities," J. Cholak, L. J. Schafer and D. W. Yeager, University of Cincinnati, Cincinnati.)

Reactions: The present work is a study of 2 reactions: 1, ozone with hydrocarbons and related compounds; and, 2, nitrogen dioxide with hydrocarbons and related compounds. The object is to determine what may be expected under atmospheric conditions, i.e., at low concentrations in air under sunlight irradiation. A number of interesting products have been discovered which may be of importance in atmospheric pollution. ("Reactions Involving Ozone, Nitrogen Dioxide, and Organic Compounds at Low Concentrations in Air," P. L. Hanst, E. R. Stephens, and W. E. Scott, The Franklin Institute, Philadelphia.)

Training Session Pinpoints Communications . . .

Oil-company management already knows that it must communicate with employes, and is doing so. The real problem is to seek orderly methods of exchanging information, particularly on subjects which are vital to the company's and its employes' mutual interest, and which may lie outside the boundaries of routine communication. It is not enough for management to do its communication "thinking" in terms of the rank and file; every stratum of supervision has essentially the same need for channels through which to hear from management and to speak to it. ("Supervision: Key to Effective Communications," M. E. Stone, Sinclair Oil Corporation, New York.)

A formalized training program for process personnel is in operation at Esso Standard Oil Company's Baton Rouge, La., refinery. A program was proposed to the union during negotiations for a new bargaining agreement in the summer of 1953. A committee, composed of three representatives each from management and union, was appointed to work out proposals agreeable to both—and the resulting program has become part of the new bargaining agreement. Although difficult to evaluate because of the relatively short experience factor, indications are that higher yields, higher production rates, and less unit downtime should be obtained. ("A Procedure for Training Process-Unit Operating Personnel," O. C. Day, Esso Standard Oil Company, Baton Rouge, La.) ##

NGAA Absorption Forum

Number of Trays—What's Their Effect?

These absorber results are based on operating data from a 45 inch diameter column located at the Hastings gasoline plant.

F. K. Kennedy III, J. N. Chancellor, Jr. and M. H. Rahmes,
Stanolind Oil and Gas Company,
Tulsa

• THE NUMBER OF theoretical plates does not increase proportionally with an increase in actual trays in the range of 20 to 40 trays. Over-all tray efficiency, with respect to all components, declines markedly with an increase in actual trays.

• The use of an over-all average tray efficiency for all components is questioned, since the test results show a significant trend toward lower tray efficiencies with respect to individual components as volatility increases from the butanes through methane.

These are the results indicated by a series of tests run on an absorber in Stanolind Oil and Gas Company's Hastings gasoline plant.

TABLE 1
Analyses of Gas Samples

	RICH GAS			LEAN GAS	
	1	2	3	1	2
20 Trays:					
CO_2	.500	.500	.300	.500	.500
Air	.240	.192	.180	.177	.171
C_1	90.621	90.531	90.569	94.654	94.651
C_2	4.725	4.761	4.700	3.920	3.933
C_3	1.942	2.033	1.946	.720	.716
iC_4	.473	.496	.506	.016	.016
nC_4	.611	.625	.619	.013	.013
(C_4)	(1.084)	(1.121)	(1.127)	(.029)	(.029)
iC_5	.244	.242	.247	.....	.....
nC_5	.198	.193	.195	.....	.....
C_6	.241	.240	.253	.....	.....
C_{7+}	.185	.186	.163	.....	.....
Total	100.000	100.000	100.000	100.000	100.000
30 Trays:					
CO_2	.500	.500	.....	.500	.500
Air	.231	.227	.....	.175	.168
C_1	90.453	90.579	.....	94.744	94.736
C_2	4.739	4.587	.....	3.884	3.910
C_3	2.015	1.992	.....	.682	.670
iC_4	.501	.489	.....	.004	.004
nC_4	.610	.597	.....	.011	.012
(C_4)	(1.110)	(1.086)	.....	(.015)	(.016)
iC_5	.241	.237	.....	.....	.....
nC_5	.197	.195	.....	.....	.....
C_6	.250	.239	.....	.....	.....
C_{7+}	.163	.158	.....	.....	.....
Total	100.000	100.000	.....	100.000	100.000
40 Trays:					
CO_2	.400	.400	.....	.200	.500
Air	.192	.224	.....	.170	.176
C_1	90.639	90.622	.....	95.033	94.743
C_2	4.803	4.794	.....	3.931	3.924
C_3	1.994	2.007	.....	.656	.644
iC_4	.506	.506	.....	.010	.008
nC_4	.627	.626	.....	.....	.....
(C_4)	(1.133)	(1.134)	.....	.....	.....
iC_5	.250	.242	.....	.....	.....
nC_5	.191	.194	.....	.....	.....
C_6	.237	.230	.....	.....	.....
C_{7+}	.161	.153	.....	.....	.....
Total	100.000	100.000	.....	100.000	100.000

Equipment and Procedure—In May, 1954, the tests were run at the Hastings plant to determine the benefit of using a greater number of actual trays in absorption. The Hastings absorbers are equipped for such a study since separate lean oil entries are provided on the 20th, 30th and 40th trays. The tests reported herein were run to check an earlier series run in 1947, which had indicated generally that there was little, if any, benefit in increasing the number of actual trays above 20-30, but which had certain inconsistencies in data.

The Hastings plant has two parallel absorbers arranged in the manner indicated. There are orifice flow meters on both the rich gas and lean gas streams at each

TABLE 2
Analytical Data Employed in Correlation

	20 ACTUAL TRAYS		30 ACTUAL TRAYS		40 ACTUAL TRAYS	
Component	**Feed**	**Residue**	**Mole Percent Feed**	**Residue**	**Feed**	**Residue**
Air	0.193	0.171	0.227	0.175	0.192	0.170
Methane	90.531	94.651	90.579	94.744	90.639	95.033
Ethane	4.761	3.933	4.587	3.884	4.803	3.931
Propane	2.033	0.716	1.992	.682	1.994	0.656
i-Butane	0.496	0.016	0.489	.004	.506	0.010
n-Butane	0.625	0.013	0.597	.011	.627	.....
i-Pentane	0.242	.....	0.237	.....	.250	.....
n-Pentane	0.193	.....	0.195	.....	.191	.....
Hexane	0.240	.....	0.239	.....	.237	.....
Heptanes+	0.186	.....	0.158	.....	.161	.....
Carbon Dioxide	0.500	0.500	0.600	0.500	.400	0.200
	100.000	100.000	100.000	100.000	100.000	100.000

LEAN OIL

Engler Distillation	**RUN**		
	20 Trays	**30 Trays**	**40 Trays**
I.B.P.	386	412	408
5 percent	422	424	433
10 percent	427	434	436
20 percent	439	443	448
30 percent	444	449	452
40 percent	450	455	458
50 percent	460	463	464
60 percent	470	469	470
70 percent	476	478	478
80 percent	487	490	489
90 percent	506	509	513
95 percent	527	531	533
E. P.	568	570	570
Loss	0.3	0.5	1.0
Residue	0.7	1.0	1.0
Mol. Wt.	189	193	192
Density (lb./gal.)	6.943	6.947	6.954

Entrainment Test on 40-Tray Run: 0.07 Gal./Mmcf

Number of Trays—Their Effect . . .

absorber. Thus, with an analysis of each stream, it is possible to determine the percent extraction of each hydrocarbon component in the absorber being tested.

The absorbers are equipped with cross-flow trays having 21 4½-inch square bubble caps. Tower diameter is 45¾ inches i.d. and tray spacing is 22 inches. Tower vapor loading, based on rich gas rate entering the absorber and using compressibility factor, was equivalent to a Brown-Souders "C" value of approximately 330.

Triplicate spot samples of rich and lean gas were taken by water displacement after line out periods of approximately twenty-three hours. Operating conditions were held as constant as possible for the entire period.

In general, the procedure for the gas samples involved analyzing duplicate samples and holding the third for later analysis, if required. Approximately 53,000 cc samples of rich gas and 138,000 cc samples of lean gas were charged in an effort to obtain maximum accuracy from the low temperature fractional distillation apparatus employed. The duplicate analyses in each case show good agreement and in the case of the rich gas for the 20-tray test, the third analysis, which was run for further confirmation only, also agreed very well.

Good splits between isobutane and normal butane apparently were obtained on the rich gas samples, but absorption calculations disclose that the splits of butanes in the residue gas analyses are not sufficiently accurate due to the small quantities present, in spite of the large sample charges employed. Accordingly, the data were correlated on total butanes. All gas analyses obtained are presented in Table 1.

The gas analyses used in correlating absorber performance, which are shown in Table 2 along with tests on the lean oil samples, were selected based on the better run on the "Pod." That is, the analysis selected in each case was the one where the smoothest operation and the sharpest cuts between components were obtained.

Methods of Correlation—Extraction of each component was obtained directly from metered volumes and analyses of rich and lean gas streams as indicated in Table 3. Absorption calculations were made by several of the generally used methods to determine apparent number of theoretical trays, which approach takes into account the effect of minor changes in variables which were experienced during the series of tests. The calculation methods employed were those described by Kirkbride and Bertetti,[1] Edmister,[2] and a modification of the Edmister method wherein a top tray equilibrium and material balance calculation is employed to determine L/V at the top tray. Equilibrium vaporization ratios employed were essentially those of Webber.[3]

The Kirkbride-Bertetti method appeared to fit the data obtained somewhat better than the other two methods and the correlations presented are based on that method.

Heat balance calculations were made using the en-

Meet the Author

F. K. KENNEDY joined Stanolind Oil & Gas Company in 1947, following his graduation from Carnegie Instute of Technology where he received a degree in mechanical engineering. Appointed as a junior petroleum engineer in South Texas, he was promoted to operating engineer at the company's La Rosa recycling plant in 1950 and in 1952, was transferred to the Hastings gasoline plant as petroleum engineer. Since last year, he has served as plant engineer at the company's Salt Creek gasoline plant at Midwest, Wyo. Kennedy presented the accompanying topic at the recent meeting of NGAA.

TABLE 4
Theoretical Plates vs. Actual Trays

	20 Trays	30 Trays	40 Trays
Methane	0.84	0.40	0.32
Ethane	1.29	1.15	1.19
Propane	4.50	5.20	4.70
Butanes	4.80	5.86	6.17

TABLE 3
Test Material Balances and Operating Conditions
(Run "A" 20 Actual Trays May 9, 1954; Run "B" 30 Actual Trays May 8, 1954; Run "C" 40 Actual Trays May 7, 1954)

	RUN "A"				RUN "B"				RUN "C"			
	Absorber Feed mscfd	Absorber Residue mscfd	Knockout mscfd	Percent Recovery	Absorber Feed mscfd	Absorber Residue mscfd	Knockout mscfd	Percent Recovery	Absorber Feed mscfd	Absorber Residue mscfd	Knockout mscfd	Percent Recovery
Air	38.47	30.86	7.61	19.78	44.61	31.55	13.06	29.28	37.75	30.72	7.03	18.62
Methane	18,046.82	17,079.78	966.94	5.36	17,800.87	17,081.07	719.80	4.04	17,818.83	17,173.32	646.51	3.62
Ethane	949.97	709.71	239.26	25.22	921.10	700.23	220.87	23.98	944.23	710.37	233.86	24.77
Propane	405.26	129.20	276.06	68.12	391.47	122.96	268.51	68.59	392.00	118.55	273.45	69.76
(Iso butane)	(98.47)	(2.89)	(95.98)	(97.06)	(96.10)	(.72)	(95.38)	(99.25)	(99.48)	(1.81)	(97.67)	(98.18)
(Butane)[1]	(124.99)	(2.35)	(122.24)	(98.11)	(117.32)	(1.96)	(115.34)	(98.31)	(123.26)	.....	(123.26)	(100.00)
Isopentane	48.24	.....	48.24	100.00	46.58	.....	46.58	100.00	49.15	.....	49.15	100.00
Pentane	38.47	.....	38.47	100.00	38.32	.....	38.32	100.00	37.55	.....	37.55	100.00
Hexane	47.84	.....	47.84	100.00	46.97	.....	46.97	100.00	46.59	.....	46.59	100.00
Heptane Plus	37.08	.....	37.08	100.00	31.05	.....	31.05	100.00	31.65	.....	31.65	100.00
CO_2	99.67	90.23	9.44	9.47	117.91	90.14	27.77	.....	78.64	36.14	42.50	54.04
Total Butanes*	253.46	5.24	248.22	97.66	213.42	2.70	210.72	98.74	222.74	1.81	220.93	99.18
Total	19,934.18	18,045.02	1,889.16	.....	19,652.20	18,059.55	1,623.65	.....	19,859.13	18,070.91	1,588.22	.....
Operating Conditions:												
Rich Gas Pressure psig	720				730				720			
Rich Gas Temperature F.	84				82				78			
Lean Gas Pressure psig	710				720				710			
Lean Gas Temperature F.	94				94				92			
Absorber Bottom Pressure psig	712				720				715			
Lean Oil Flow gpm	207.3				207.5				208.6			
Lean Oil Temperature F.	89				88				86			
Lean Oil Vapor Pressure	..... less than				15 mm H_2O				.....			
Rich Oil Temperature F.	86				96				93			
Atmospheric Temperature F.	86				88				81			

* These butane figures used for purposes of calculations.

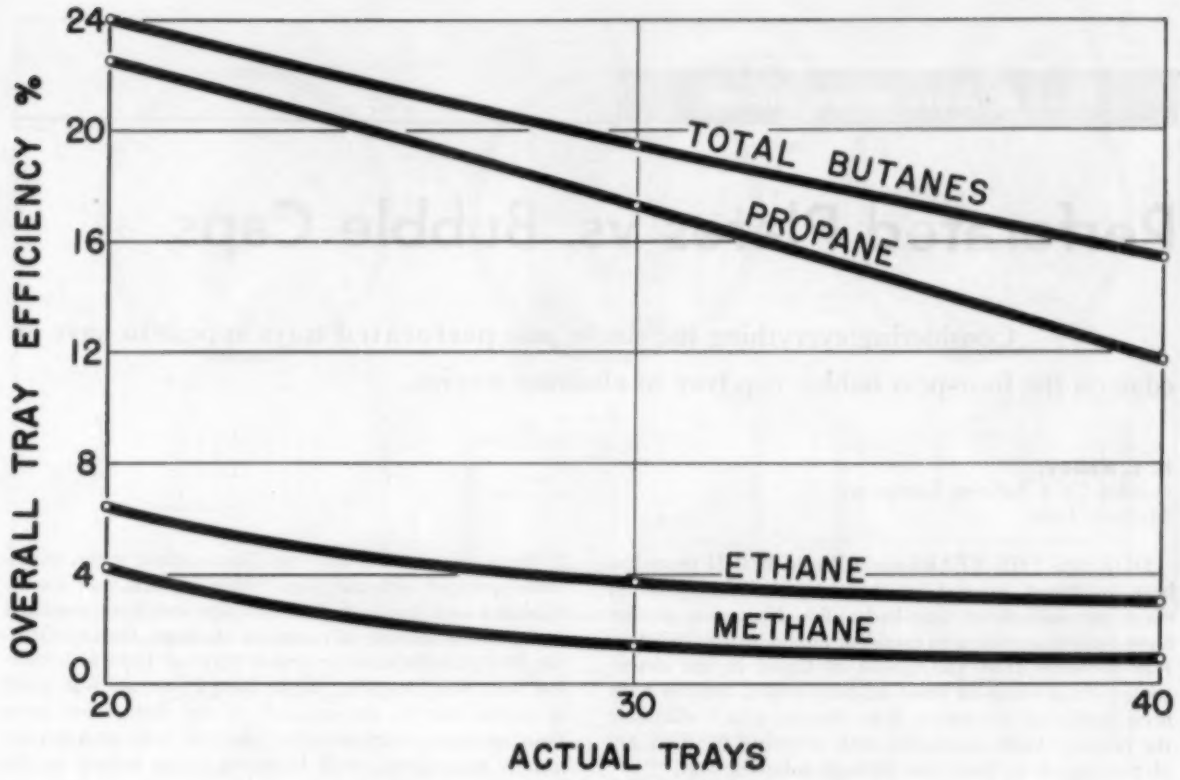

FIGURE 1—Tray Efficiency as a function of actual trays.

thalpy charts of Schiebel and Jenny.[4] Heat balances checked quite well; the discrepancy, if considered to be entirely due to rich oil temperature, ranges between less than 1F. for the 20-tray test and about 3F. for the 40-tray test.

Figure 1 is a plot of tray efficiencies of individual components obtained with the Kirkbride-Bertetti method versus number of actual trays. Two trends are evident from the plot; (1) tray efficiency declined markedly with an increase in the number of actual trays and (2) tray efficiency with respect to the individual components decreased as their volatility increased.

With regard to the first observation, this trend confirmed the findings of an earlier series of tests. The results indicate that the usual industry practice of employing only 20-30 actual trays in absorbers probably is proper. Table 4 indicates that a slight increase may result from the use of 40 trays in regard to butane extraction, but that propane extraction may even decline slightly between 30 and 40 trays. The effect on propane extraction may not be real since a relatively small analytical discrepancy could account for it.

The second observation could have some effect on the design and performance of the remainder of the absorption-distillation system. If the trend found in these tests is representative of absorbers in general, then somewhat less methane and ethane are present in rich oil than would be indicated on the assumption that a single tray efficiency applies to all components. Thus, somewhat smaller facilities would be required for eliminating these undesired constituents.

There is some confirmation of the effect of component volatility on tray efficiency with respect to a given component. Edmister[5] notes such an effect with respect to methane and the earlier absorber tests at Hastings and other unpublished data show some such tendency. The trend was generally indicated when the data were correlated by the other calculation methods, although the efficiency for propane was higher than for butanes in the 20-tray tests when calculated by the Edmister method.

It is recognized that relatively small errors in analyses, particularly for methane, could have a very pronounced effect on the indicated tray efficiencies. It is believed that additional confirming data, particularly from absorbers operating at other pressures and on richer gas, are necessary before it would be advisable to attempt to apply extensively the information obtained from these tests.

This discussion was presented at the NGAA meeting, Dallas, April 17, 1955.

ACKNOWLEDGMENT

The authors wish to express their appreciation to the management of Stanolind Oil and Gas Company for permission to present and publish the results of these tests.

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NGAA Absorption Forum

Perforated Plates vs. Bubble Caps

Considering everything the single pass perforated trays appear to have an edge on the four-pass bubble cap tray in absorber service.

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DURING THE YEARS since World War II there has been increased interest in the design of fractionation trays, particularly in tray hydraulics. Numerous studies have been undertaken to establish methods of calculating tray pressure drop and height of liquid in the downcomer. As a result of these studies, several articles have been published discussing tray designs which eliminate the pressure losses associated with reversing the direction of the vapors as they pass through a bubble cap.

One of these trays is the perforated tray. In addition to pressure drop and capacity advantages, considerable advantages have been claimed for perforated trays over bubble cap trays with respect to initial cost, efficiency, and maintenance. When it became necessary to replace the trays in one of the refinery absorbers, it was decided to install perforated trays not only because of a slightly lower investment, but also to obtain operating information on this type of tray. This presentation shows the results of a series of plant tests conducted on two parallel absorbers, one equipped with perforated trays and the other with bubble cap trays. Tray pressure drop, capacity, and efficiency were investigated and conclusions drawn.

Description of Equipment—Absorbers A and B are two parallel absorbers which operate at 65 psig and 90 F. lean oil temperature to recover propane, butanes and heavier from various plant gas streams. Details of the tray layouts are shown in Figure 1.

Absorber A is six feet one and one-half inches i.d. with 25 trays on two-foot spacing. The original trays, which were equipped with cast iron bubble cap and riser assemblies and with five-inch diameter pipe overflows, required replacement because of corrosion damage. During October, 1953, single pass perforated trays of Type 410 stainless steel were installed. Since design gas rate was small in comparison to the capacity of the shell, more holes than necessary were punched and the hole area not required was closed with blanking strips bolted to the under under side of the tray. To minimize fabrication cost and maximize flexibility, all trays were punched alike. More hole area was blanked on the top trays than at the bottom so as to compensate for diminishing vapor rate.

Absorber B is seven feet six inches i.d. with 25 trays on two-foot spacing. The trays are four-pass bubble cap trays with box and segment downcomers. There are two types of caps on each tray: 5 round and 36 elongated caps. Trays are identical throughout the absorber.

Lean oil was fed to each absorber on rate-of-flow control and rich oil was removed on liquid level control. Absorber pressure was maintained by a pressure controller in the residue gas line. The pressure on each absorber was readjusted manually as required to maintain the proper gas distribution between the absorbers. Mercury manometers were installed to measure the pressure drop through the absorbers under test conditions. Pressure drop was measured from the vapor space below the bottom tray to a point of equal elevation on the residue gas knockout drum. It was necessary to subtract the pressure drop through the overhead vapor line, which was calculated using the Fanning equation plus entrance and exit losses.

Test Procedure—The capacity tests were carried out by slowly increasing the loading until flooding was evidenced by continued increase in differential pressure at constant loading. Further indications of flooding were carryover of liquid into the absorber knockout drums. Loading on Absorber B was increased by raising the feed gas rate at constant lean oil rate. Due to control difficulties encountered during the Absorber A capacity tests, feed gas and lean oil were, of necessity, increased simultaneously. Shortage of feed gas prevented testing

Meet the Author

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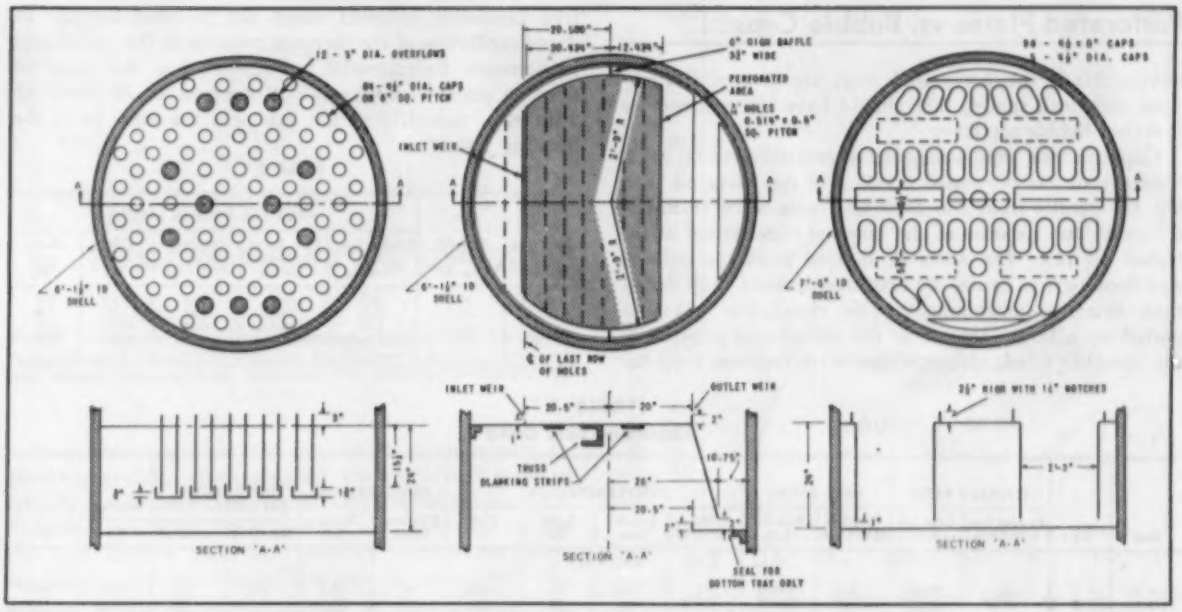
12 - 5" DIA. OVERFLOWS
84 - 2½" DIA. CAPS ON 6" SQ. PITCH
6'-11½" ID SHELL
INLET WEIR
6" HIGH BAFFLE 32" WIDE
PERFORATED AREA
2" HOLES 0.516" x 0.6" SQ. PITCH
2'-0" R
5'-6" R
℄ OF LAST ROW OF HOLES
96 - 2½" x 8" CAPS
1 - 2½" DIA. CAPS
7'-0" ID SHELL
SECTION "A-A"
OUTLET WEIR
TRUSS BLANKING STRIPS
SEAL FOR BOTTOM TRAY ONLY
3½" HIGH WITH 14" NOTCHES

FIGURE 1—Diagrams of the absorbers. Left, Absorber A, original tray. Center, Absorber A, perforated tray. Right, Absorber B. Read with table appearing in column at right which shows "Areas as Percent of Column Cross Sectional Area."

both absorbers at the same time, resulting in small variations of feed gas composition between tests on the two absorbers. For that reason the relative absorber efficiencies could not be determined by direct comparison of residue gas composition, but rather by correlation of percent recovery with effective absorption factor.

Samples for efficiency calculations were taken after about two hours on conditions to assure complete displacement of both gas and liquid from the absorbers.

Gas analyses were made by mass spectrometer. In order to obtain the high order of accuracy required on the lighter components in the lean and rich absorber oils, these oils were cut on a Podbielniak column and the light fractions analyzed by mass spectrometer.

Complete test data are listed in Table 1. See next page.

Discussion of Results

A. *Capacity*—An indication of the relative capacities of the various tray layouts used in Absorbers A and B is shown in Figure 2 in which feed gas is plotted against rich oil in terms of volume rates per square foot of column cross section. This method of plotting places the comparison of the two absorbers, which are of different diameters, on a common basis. Limiting oil and gas rates are shown in Table 2.

Substitution of perforated trays in Absorber A resulted in a substantial increase in capacity even though the perforated trays were designed for gas and liquid rates of about half of those which might be expected as ultimate

TABLE 2

Absorber No.		Feed Gas M scf/D/Ft.²	Rich Oil B/D/Ft.²
A	Bubble Cap	348	448
A	Perforated (as is)	543	922
A	Perforated (blanking strip removed)	649	923
B	Bubble Cap	663	957
B	Bubble Cap	894	1,210

	Absorber A Original Tray	Absorber A Perforated Tray	Absorber B
Downcomer (Top)	5.3	17.1	11.3
Downcomer (Bottom)	5.3	9.0	9.8
Downcomer Clearance	2.3	2.4	4.1
Riser Area	11.7	....	7.2
Hole Area:			
Trays 1- 5	....	3.9	....
Trays 6-15	....	3.7	....
Trays 16-35	....	2.4	....

for a tower of the same diameter. The limiting feed gas for the original tray was estimated from a test in which only residue gas and lean oil were reported by assuming the same recovery as found in the more recent tests on the same type of feed gas at comparable lean oil-to-residue gas ratios. A further correction was necessary to adjust from a pressure of 45 to the 65 psig of the other tests reported here. Consideration of the old tray layout as shown in Figure 1 points to the five-inch diameter overflows as the probable limitation. Overflow velocities were somewhat high at 0.72 feet per second, but more important, the seal cups at the bottom of the overflows had a tendency to foul. It is quite possible that they were partially fouled when the capacity of the trays was measured. However, the point on Figure 3 represents the maximum usable capacity of the original trays.

Perforated trays had been in Absorber A about two months at the time of the tests reported here. During that time and including the test work, the absorber was operated over a wide range of oil and gas rates with no apparent difficulties. Absorber pressure drop was measured at the beginning and at the end of the period. No change was noted, but a much longer period of operation with an inspection at the end, will be required to determine whether or not perforated trays resist fouling better than bubble cap trays. To date, the trays have been in operation for more than sixteen months without cleaning or inspection. There has been absolutely no evidence of fouling even though the absorber has been operated at very low gas rates at times. Based on this operating experience, it is predicted that the perforated trays will prove to be entirely satisfactory in this relatively clean

Perforated Plates vs. Bubble Caps . . .

service. Since the perforated trays are free of obstructions and dead spaces, they should have less tendency to foul than bubble cap trays.

Capacity tests were attempted at two different oil rates. Shortage of gas prevented flooding at the lower oil rate, but the results from the combined tests serve to isolate the cause and location of the flooding experienced at the higher oil rate. The absorber flooded from the bottom, and flooding was caused by excessive pressure drop rather than excessive entrainment. This conclusion was supported by a large increase in the differential pressure as the absorber filled, although the exact pressure drop before carryover occurred could not be read because of rapid oscillation of the mercury columns in the undamped manometer. Entrainment is discounted as the cause of flooding since flooding was not observed at the lower oil rate even though feed gas rate was the same as in the flooding test.

TABLE 3

Feed Gas Ft³/ Sec/Ft²	Rich Oil Hot gpm/Ft²	PRESSURE DROP IN INCHES				
		Bottom Tray △P, "Hot Liq.	Calc. Ht. In Downcomer " Hot Liq.	Top Tray △P, "Hot Liq.	Calc. Total "Hg	Measured "Hg
0.764	16.2	5.32	...	3.15	5.65	5.3
1.142	23.7	9.06	16.06	4.56	8.6	7.6
1.217	21.9	8.90	15.4	6.02	10.2	10.6
1.213	28.0	9.35 Flood	17.06	5.74	10.3	10.3

TABLE 1
Absorber Test Data

Date	No.	METERED RATES		CALC RATES[1]		TEMPERATURES, °F.				PRESSURE, PSIG.		DIFFERENTIAL PRESSURE, IN. HG.		Recovery,	$Y_{out}-Y_1$ / $Y_{out}-Y_o$
		Residue Gas MM CF/D	Lean Oil B/D	Feed Gas MM CF/D	Rich Oil B/D	Feed Gas[2]	Residue Gas	Lean Oil	Rich Oil	Knockout Drum	Tower Top	Measured	Corrected[3]	C_3	iC_4
						ABSORBER A									
1/4/54	1	5.1	12,500	9.6	15,680	85	112	98	133	64	64.6	6.6	5.3	48.8	95.0
1/5/54	2	7.83	18,000	14.9	22,980	85	110	92	131	65	65.4	10.5	7.6	48.7	94.0
1/6/54	3	10.2	23,200	16.0	27,210	85	103	92	127	63	65.1	14.6+Flood	10.3	41.4	90.7
1/6/54	4	11.6	18,000	16.1	21,200	85	110	92	133	63	66.0	16.9	10.8	26.8	70.5
						ABSORBER B									
1/5/54	1	7.46	18,500	14.0	23,090	85	104[3]	90	125	66	66.2	3.8	2.5	51.5	96.4
1/5/54	2	12.6	27,100	19.9	32,240	85	105	90	126	66	66.5	5.75	4.8	44.8	95.5
1/7/54	3	19.6	35,500	29.3	42,310	85	103	90	127	66	67.1	9.5+Flood	7.4	37.5	92.5
1/7/54	4	14.3	45,200	26.2	53,400	85	102	90	125	66	66.5	8.8+Flood	7.7	67.1	99.0

Hydrocarbon Analyses

ABSORBER A

NUMBER	FEED GAS, MOLE PERCENT				RESIDUE GAS, MOLE PERCENT				LEAN OIL, L. V. PERCENT				RICH OIL, L. V. PERCENT	
	1	2	3	4	1	2	3	4	1	2	3	4	1	2
Acid Gas[4]	3.0	4.0	5.0	5.0	3.0	4.0	5.0	5.0	....	....	....	....	....	....
CO	1.3	1.2	2.6	2.3	1.7	2.1	4.1	3.0	....	....	....	....	....	....
N_2	0.0	0.0	1.3	0.6	0.0	0.0	2.0	1.8	....	....	....	....	....	....
H_2	1.3	1.9	4.0	3.5	2.3	3.4	6.2	4.6	....	....	....	....	....	....
C_1	14.2	12.1	21.6	20.0	25.3	21.9	21.9	26.5	....	....	....	....	0.2	0.2
C_2=	1.9	3.6	5.3	5.0	2.8	5.2	7.3	6.4	....	....	....	....	0.3	0.3
C_2	19.1	16.0	12.7	13.9	29.9	23.5	16.5	17.0	....	....	....	....	1.3	1.1
C_3=	8.8	15.8	15.2	13.9	8.5	15.8	13.7	15.8	....	Tr	....	....	1.0	2.5
C_3	25.6	22.1	12.2	15.0	24.8	21.8	11.1	15.1	Tr	Tr	....	....	5.1	4.8
iC_4	9.4	9.7	4.4	6.0	1.0	1.2	0.7	2.5	0.1	0.1	....	Tr	4.8	5.7
nC_4	9.0	7.7	4.3	5.8	0.5	0.5	0.3	0.7	0.2	0.1	0.1	0.1	6.9	5.0
C_4=	3.2	3.0	7.0	6.0	0.1	0.2	0.2	1.2	Tr	Tr	Tr	Tr	2.7	2.1
iC_5	1.3	0.7	0.6	1.0	0.1	0.1	0.8	0.2	0.1	0.0	0.2	0.2	0.9	1.2
nC_5	0.7	0.8	1.4	0.4	Tr	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.4	0.5
C_5	0.7	0.8	1.3	1.0	Tr	0.1	0.1	0.1	0.1	0.0	0.2	0.2	0.3	0.6
C_6+	0.5	0.8	1.1	0.6	0.0	0.0	0.0	0.0	99.4	99.7	99.4	99.4	76.1	76.0
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

ABSORBER B

NUMBER	FEED GAS MOLE PERCENT				RESIDUE GAS, MOLE PERCENT				LEAN OIL, L. V. PERCENT				RICH OIL, L. V. PERCENT				TYPICAL LEAN OIL	
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	Percent	°F.
Acid Gas[4]	4.0	5.0	5.0	5.0	4.0	5.0	5.0	5.0	....	....	....	....	....	....	....	....	IBP	347
CO	1.2	2.1	2.5	2.5	1.4	2.7	3.2	3.7	....	....	....	....	....	....	....	....	5	389
N_2	0.0	0.5	1.3	1.1	0.0	2.0	2.5	2.8	....	....	....	....	....	....	....	....	10	391
H_2	1.8	3.2	4.3	3.6	3.5	5.2	5.6	6.6	....	....	....	....	....	....	....	....	20	395
C_1	11.8	17.3	19.8	18.5	21.5	26.4	29.0	32.9	....	....	....	....	0.1	0.1	0.1	0.1	30	399
C_2=	2.3	4.7	5.2	4.7	3.7	6.4	7.0	7.3	....	....	....	....	0.2	0.2	0.3	0.2	40	401
C_2	18.0	15.2	13.7	14.2	28.6	20.6	18.2	20.5	....	....	....	....	1.1	0.7	1.0	0.6	50	404
C_3=	13.0	15.1	15.4	15.5	13.2	14.4	14.7	11.3	Tr	....	Tr	....	2.6	2.2	3.2	2.5	60	407
C_3	25.0	18.3	13.6	14.6	22.7	15.8	12.6	8.8	Tr	Tr	Tr	....	5.1	3.1	3.1	2.6	70	411
iC_4	8.8	7.4	5.5	5.6	0.7	0.7	0.8	0.1	0.1	0.1	0.1	0.0	3.7	3.6	3.7	2.7	80	415
nC_4	8.7	5.2	4.6	6.0	0.4	0.5	0.7	0.4	0.2	0.2	0.2	0.1	4.3	3.0	3.4	2.8	90	423
C_4=	2.7	3.9	5.2	5.3	0.2	0.3	0.3	0.2	Tr	0.1	0.2	0.0	1.1	2.2	3.5	2.4	95	429
C_5	1.0	0.6	0.0	0.0	0.2	0.1	0.2	0.2	0.1	0.1	0.2	0.2	0.5	0.9	1.0	0.5	FBP	453
nC_5	0.6	0.5	1.0	0.9	Tr	Tr	Tr	0.1	0.1	Tr	0.1	0.2	0.2	0.4	0.3	0.4	....	....
C_5=	0.6	0.6	0.7	0.7	Tr	Tr	0.2	0.1	Tr	0.1	0.3	0.2	0.2	0.7	0.9	0.6	Recovery	99.0
C_6+	0.5	0.7	2.0	1.8	0.0	0.0	0.0	0.0	99.5	99.4	98.9	99.2	90.4	82.4	79.2	84.4	Residue	0.8
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	Loss	0.2

Notes: [1] Calculated by methane balance.
[2] Estimated due to lack of means for direct measurement.
[3] Differential pressures corrected for pressure drop through overhead vapor line.
[4] Acid gas estimated. Analyses were not representative due to reaction with sample container.

Lean Oil Properties

Visc. at 100 °F.	1.4 centistrokes
°API	44.6
Mean average B.P.	411°F.
Characterization Factor	11.9
Mole Wt.	165

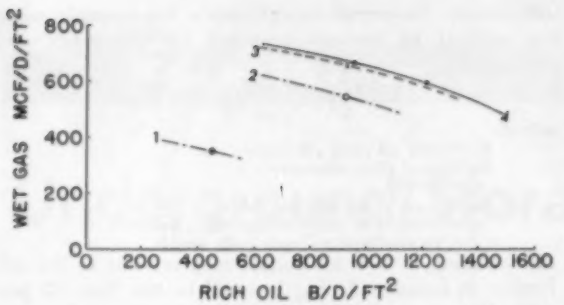

FIGURE 2—Absorber Capacity: 1. Absorber A—Original Tray (estimated from lean oil & dry gas). 2. Absorber A—Perforated tray. 3. Perforated tray without blanking strips (estimated). 4. Absorber B—Bubble cap tray.

Calculated and measured total pressure drops were in good agreement, which supports the calculated pressure drop of 9.4 inches of hot liquid as the flooding point for the perforated trays. Pressure drop was calculated for the top and bottom trays and several intermediate trays assuming equal percentage knockout on each tray. The average multiplied by the number of trays checked the measured pressure drop in most cases as shown in Table 3.

Pressure drop through the holes was calculated from the equation and data given by Arnold, Plank and Schoenborn[1] of North Carolina State.

$$\Delta P = K \times \frac{\rho_V}{s_L} (V_{hole})^{1.8} = \text{inches of hot liquid}$$

where: ρ_V = vapor density, #/ft.³; s_L = liquid specific gravity; V_{hole} = hole velocity, ft./sec.

The constant, K, varied with hole size and percent open area. For the trays in Absorber A, K was equal to 0.0162. The hole pressure drop corresponds within the accuracy of the measurements to an orifice coefficient of 0.6 which is somewhat lower than that given by Mayfield, et al[6]. The maximum hole pressure drop before flooding was 5.3 inches of hot liquid. Published data indicate that at the same liquid rate the minimum pressure drop before weeping would be 0.5 inches of hot liquid. Assuming that the hole pressure drop is proportional to the square of the vapor velocity, satisfactory operation would be achieved over the range from 31 to 100 percent of capacity. As pointed out, this is as good as most bubble cap trays and better than some. In most cases, the control instrumentation restricts the operability range to something less than that of the trays.

The hydrostatic head was calculated by multiplying the calculated level at the outlet weir, $h_w + h_{ow}$, by an aeration factor, f. The aeration factor was approximated by extrapolation of data for a two-inch weir presented by Mayfield, et al[6], as:

$$f = 0.54 + 0.0023 \text{ (gpm/foot diameter)}$$

Pressure drop at flooding conditions for the four-pass bubble cap trays in Absorber B was calculated to be of the order of 7.5-8.5 inches of hot liquid. Two flooding tests were carried out at lean oil rates differing by 27 percent. In both tests the absorber appeared to flood from the bottom, the point of greatest loading. The same procedure for averaging differential pressures as was used in Absorber A calculations was followed with results as shown in Table 4.

TABLE 4

Feed Gas Ft³/ Sec/Ft²	Rich Oil Hot gpm/Ft²	PRESSURE DROP IN INCHES: Bottom Tray ΔP, "Hot Liq.	Calc. Ht. In Downcomer "Hot Liq.	Top Tray ΔP, "Hot Liq.	Calc. Total "Hg	Measured "Hg
.728	15.9	3.39	....	1.90	3.5	3.5
1.024	22.1	4.91	....	2.72	5.1	4.8
1.475	29.0	8.39 Flood	12.34	4.00	8.2	7.4
1.320	36.6	7.36 Flood	13.35	3.32	7.0	7.7

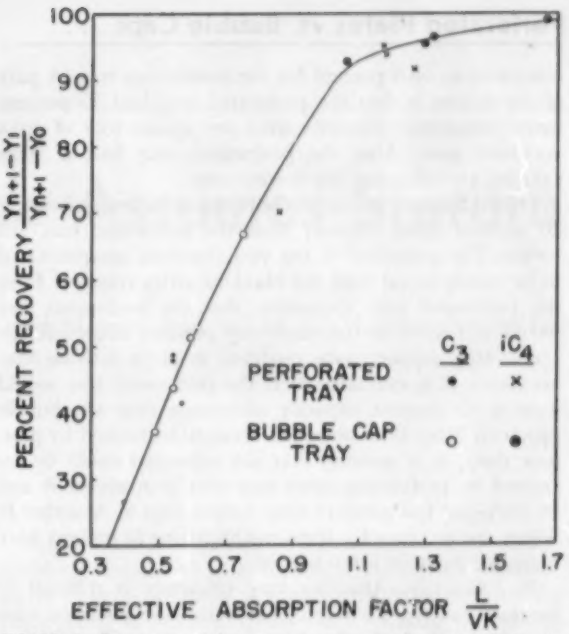

FIGURE 3—Propane and butane recovery vs. absorption factor in perforated trays and bubble cap trays.

Pressure drop calculations were made by using the equations developed by Dauphine[2] with the following exceptions:

1. Since more than one type of cap was present on a tray, it was necessary to construct a graph of pressure drop versus vapor rate for both types so that the total vapor could be proportioned among the caps such that all caps would have the same pressure drop.

2. Effective hydrostatic head was calculated as: $(h_{ow} + h_w - h_s)$ f where:

h_w = weir height, inches
h_{ow} = head over weir, inches
h_s = slot height, inches

and the aeration factor, f, was the same as used for perforated tray calculations.

There are some discrepancies between calculated and measured differential pressures at the high rates for both absorbers. However, since the manometers were installed primarily as a test instrument to follow the loading of the absorbers and to detect flooding, the agreement of calculated and observed pressure drops to within 10 percent should probably be considered good. It is of interest that the maximum pressure drop before flooding was greater for the one-pass perforated tray even though it had more head over the outlet weir and more pressure drop under the downcomer than did the four-pass bubble cap tray. The calculated maximum height in the downcomer of the perforated tray was 73.5 percent of the tray spacing as

compared to 55.6 percent for the bubble cap tray. A part of the reason is that the perforated tray had 50 percent more downcomer entrance area per square foot of cross sectional area. Also, the perforated tray had a large calming area ahead of the downcomer.

Figure 2 shows that the bubble cap absorber had nearly 20 percent more capacity than the perforated tray absorber. The capacities of the two absorbers are estimated to be nearly equal with the blanking strips removed from the perforated tray (assuming that the perforated tray would still flood at the same tray pressure drop). If the center tray support were modified so as to activate that area also, it is estimated that the perforated tray would have a 10 percent capacity advantage over the bubble cap tray. Since both absorbers seem to be limited by pressure drop, it is possible that the capacities could be increased by perforating more tray area in Absorber A and by installing low pressure drop bubble caps in Absorber B. There are no plans for these modifications at present since increased capacity is not needed.

B. *Efficiency*—Absorber tray efficiency is difficult to measure exactly. Therefore, two runs were made on each absorber with both absorbers having as nearly identical conditions as possible to determine whether or not there was any measurable difference in hydrocarbon recovery which would serve to indicate any variation in efficiency between the perforated and the bubble cap trays. These data, which cover the range of 60 to 93 percent of Absorber A and 51 to 73 percent of Absorber B capacity, are summarized in Table 5.

Percent recovery of propane and isobutane were correlated with an effective absorption factor, A_e, calculated by the method of Edmister where:

$A_e = \sqrt{A_o(A_1 + 1) + 0.25} - 0.5$ = effective absorption factor

and

A = absorption factor, L/VK
L = liquid flow rate
V = vapor flow rate
K = equilibrium constant

A_o and A_1 were calculated from the conditions on the bottom and top trays, respectively, assuming equal percentage knockout on each tray.

Figure 3, on which are plotted recoveries versus effective absorption factors for both the efficiency tests and the capacity tests, shows that there was no significant variation in recovery from one absorber to the other. The lower limit of operation was not determined. There was no significant change in efficiency for either column over the range studied.

One might think that the single- pass tray would be significantly more efficient than the four-pass tray because of a twofold advantage in the length of the liquid path. However, due to the very low point efficiencies encountered in absorbers, the length of liquid path has little influence on the overall tray efficiency. For example, using the method of analysis proposed by Gautreaux and O'Connell[4],

$$E_o = A\left[\left(1 + \frac{E_p}{nA}\right)^n - 1\right]$$

where:

E_o = over-all plate efficiency
E_p = local plate efficiency
A = L/Vm
m = slope of equilibrium curve
n = number of stages on the plate, assumed proportional to liquid path length

the variation in over-all butane recovery due to the difference in liquid path length would be less than 0.5 percent. Unfortunately, the variation in recovery due to a difference in point efficiency is also small, such that a 15 percent change in point efficiency would only change butane recovery by 1.5 percent. Therefore, from the recovery data it can only be concluded that the trays are of identical efficiency for absorber service. Tests in a fractionating tower would be required for a more accurate comparison of the efficiencies of perforated and bubble cap trays.

Conclusions—This study has pointed out that perforated trays are entirely satisfactory for service in absorbers in so far as capacity and efficiency are concerned. Good fouling characteristics have been demonstrated in a relatively clean service.

The perforated tray installed in Absorber A had substantially more capacity than did the original bubble cap tray. It is estimated that the single-pass perforated tray with blanking strips removed would have essentially the same capacity as a four-pass bubble cap tray.

Now that good methods for calculating hole pressure drop, hydrostatic head, and weep point are available in the literature[1, 5, 6, 7] it should be much easier to design a perforated tray with adequate flexibility than to design an equivalent bubble cap tray.

This presentation was at the NGAA meeting in Dallas, April 15, 1955.

ACKNOWLEDGMENT

The author wishes to thank Humble Oil & Refining Company for permission to publish the above data.

TABLE 5

Absorber	Run	Feed Gas M scf/D	Lean Oil B/D	ABSORPTION FACTOR, A_o		RECOVERY, %	
				C_3	iC_4	C_3	iC_4
A	1	9,600	12,500	0.54	1.14	48.6	95.0
	2	14,900	18,000	0.54	1.18	46.7	94.0
B	1	14,000	18,500	0.60	1.33	51.5	96.4
	2	19,900	27,100	0.54	1.20	44.8	95.5

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[6] Mayfield, F. D., Church, W. L., Green, A. C., Lee, D. C., Rasmussen, R. W., "Perforated-Plate Distillation Columns," *Ind. and Eng. Chem.*, 44, 2238 (1952).
[7] Zenz, F. A., "How to Calculate Capacities of Perforated Plates," *Petroleum Refiner*, 33, 99 (February, 1954).

More About Absorption . . .

Tray Efficiencies: The various definitions of tray efficiency were briefly summarized and prediction of tray efficiency by the method of combining individual phase resistances is described and applied to the operating and design conditions of an absorber. It is suggested that design for good tray efficiency is as important as design for capacity but that the former is seldom considered in design. A good design should be based upon both considerations, but mass transfer rates are not as well understood as capacities. Current cooperative research should add much to our knowledge in the next few years. ("A Progress Report on Tray Efficiency Studies," Brymer Williams, University of Michigan, Ann Arbor.) ##

Underground Storage Assumes Stature

Here are the details on washing techniques and what the future holds for LPG storage.

Neal E. Van Fossan,
Texas Natural Gasoline Corporation, Tulsa

UNDERGROUND STORAGE has come a long way since the first usable solution cavity was developed by the Texas Natural Gasoline Corporation in the Permian salt beds of Upton County, West Texas. The well was drilled in the late part of 1949 and was initially washed to 50,000 barrels.

Certain fixed ideas should be established in the reader's mind as to the selection of the location for the storage unit and also in the various procedures necessary to develop that unit. It matters little how well the containing media will fit the requirement if it is not in such a geographic location as to make it feasible for either production, export staging or marketing storage. The beginning point then, is to decide where the storage is wanted, and then to investigate the available containing media. When a desirable location has been established and a containing media located that will be impervious to the passage of the product to be stored; it must further be established that no contaminants are contained therein (namely sulfur, hydrocarbon residues, hydrogen sulfide, etc.) that it is amiable to removal by practical and economical methods, that it is of sufficient thickness to render unit cost of developed volume economically practical, has sufficient over-burden to give static pressures at the cavity ceiling in excess of the contained or operating pressures of the cavity and, finally, that it will have proper capping formations to permit an acceptable washing procedure.

Two major items are now injected into the problem—that of obtaining fresh wash water in sufficient supply to develop the proposed storage section and to have adequate, economical, methods of disposing of brine produced as a result of this development. Water may be obtained from drilled water wells, from rivers or lakes, and from the ocean.

Brine disposal is one of the most difficult of all the problems associated with underground storage development. Several methods are presently being utilized for the disposal of brine. Disposal wells are being drilled into sections of high porosity and permeability or in cavernous sections generally associated with the salt dome type of operation. Disposal wells may be used to supplement other water supplies in the flooding of adjoining oil fields. A step development of an underground storage well may be carried on concurrently with a disposal well. The disposal well is sometimes drilled into the loss of circulation zones in such a manner that it may be later re-completed as a storage well. Disposal wells have a further advantage in economical use of land area. Several disadvantages are associated with them in that the initial cost, maintenance and workover of the well is exceed-

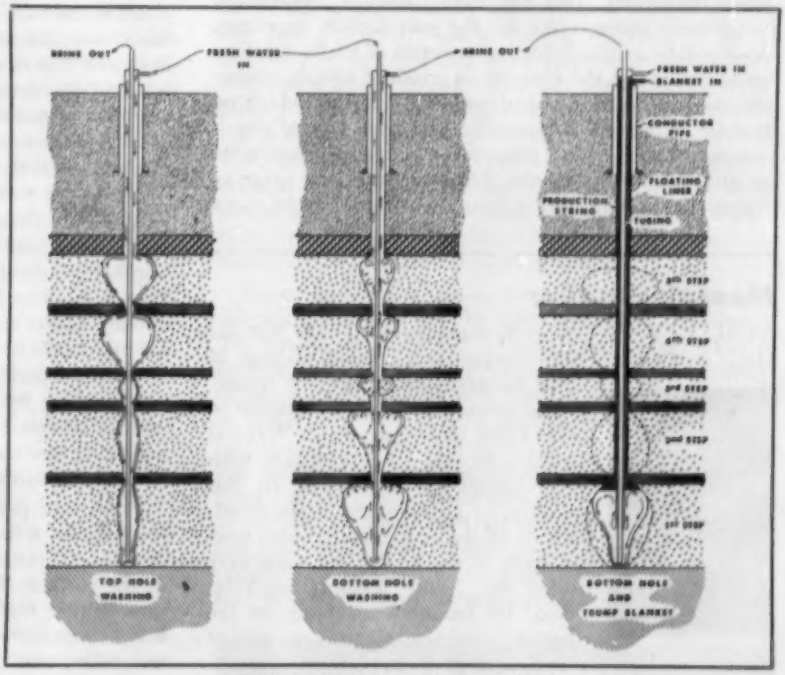

FIGURE 1—Salt bed washing procedures.

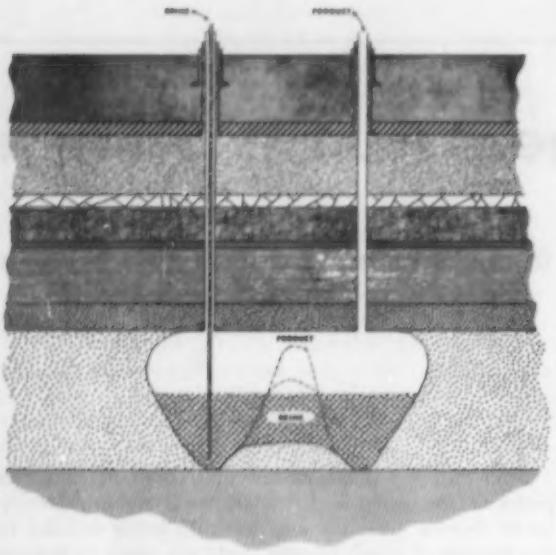

FIGURE 2—U-tube washing and storage

ingly high. There are dangers of bridging the loss of circulation zone and losing the facility; it can never be known at what time this will occur, nor at what rate a proposed disposal well will carry off the brines. There is always a possibility of charging fresh water sands in the immediate vicinity of a disposal well with salt water. It is also evident that if brine is dumped to a disposal well it will not be available for use in the recovery of product and, as a consequence, fresh water must be used.

Brine is disposed of by evaporation in many West Texas operations. This has several obvious advantages. Large brine storage pits are the only facility necessary. Brine will be available for regeneration of zeolite treaters, for sale, and for the recovery of product whenever storage chambers have reached capacities beyond which no increase is desired. Evaporative pits have several disadvantages, mainly, that evaporative rates are dependent on atmospheric conditions. This will limit the usage of evaporative pits to arid regions. Considerable land space is required because the surface area of the evaporative pit must be of such magnitude that brine disposal rates by evaporation will not limit brine production rates. It is extremely difficult to build pits which will not leak by seepage. High winds associated with the West Texas area and consequent wave action on the side walls of the pit are conducive to breakouts. A sudden flood of 100 percent saturated salt water over the verdant pastures of the West Texas ranchmen is frowned upon. Salt precipitation will occur in the pits due to the evaporation, and over periods of time this salt must be removed to maintain volume space.

Some brines are being disposed to rivers and streams. The obvious advantage in this method is low cost and ease of handling, and the disadvantages are just as obvious. Regulatory provisions on permissible parts per million concentration of salt water in fresh water streams, are sometimes rather rigid and as a consequence auxiliary pits must be constructed to take care of brine production during periods of low river levels. It is also evident that no brine will be available for recovery of stored product using this method. Disposal of brine to ocean areas has great advantage in low cost and utility and there are no great objections to this type method in that brine is being dumped to an already unusable fluid. Naturally, recovery brines will not be available.

When all of the associated problems thus far discussed have been eliminated and the time has come to actually drill the well, very careful procedures must be initiated and carried through with meticulous detail. Drilling techniques are quite similar to normal oil field procedures; the main difference being that larger casing strings are generally used, that greater care is used in picking casing seats, and that very careful procedures are used in the cementing of all casing strings. The characteristic of all insoluble stringer should be investigated in relation to their structural strength, porosity and permeability.

After the hole has been drilled and it has been established that the area to be utilized for the storage cavity is indeed practical, the problem of proper mechanics of washing the area, that is, the pumping of fresh water into the proposed storage area and thus removing the salt by solution, must be given careful attention. Several washing theories exist and will be discussed in detail. Each has its own time and place of application.

A storage chamber may be washed by top hole washing, bottom hole washing, a combination of top and bottom hole washing, or by U tubing two separate wells (see Figure 1). Top hole washing presupposes that the production casing string will be set in a completely impervious, structurally strong formation, and that the cement job will be perfect. In this procedure a tubing string is run into the open hole to the bottom of the proposed storage section. Fresh water is introduced down the casing string and enters the storage area immediately under the capping formation (see Figure 1).

From that point it descends past the exposed soluble section until it has reached the end of the tubing (at total depth) and returns through the tubing to be disposed of at the surface. This type washing procedure has advantage in that high early saturation of the washing media will be established and thus high efficiencies of washing can take place. The well may be pumped at a high rate and still maintain washing efficiency, all soluble sections

Meet the Author

NEAL E. VAN FOSSAN, manager of Texas Natural Gasoline Corporation's Storage & Terminal division in Tulsa, has been connected with underground storage since it was started in 1949. Prior to joining Texas Natural Gasoline, he was a field engineer with Slick-Urschel Oil Company. In this capacity, he participated in the development of the first underground storage wells in the U. S. The wells were drilled by Texas Natural in West Texas. He has been in charge of the company's storage and terminal system since 1953. Van Fossan is a mechanical engineering graduate from the University of Illinois.

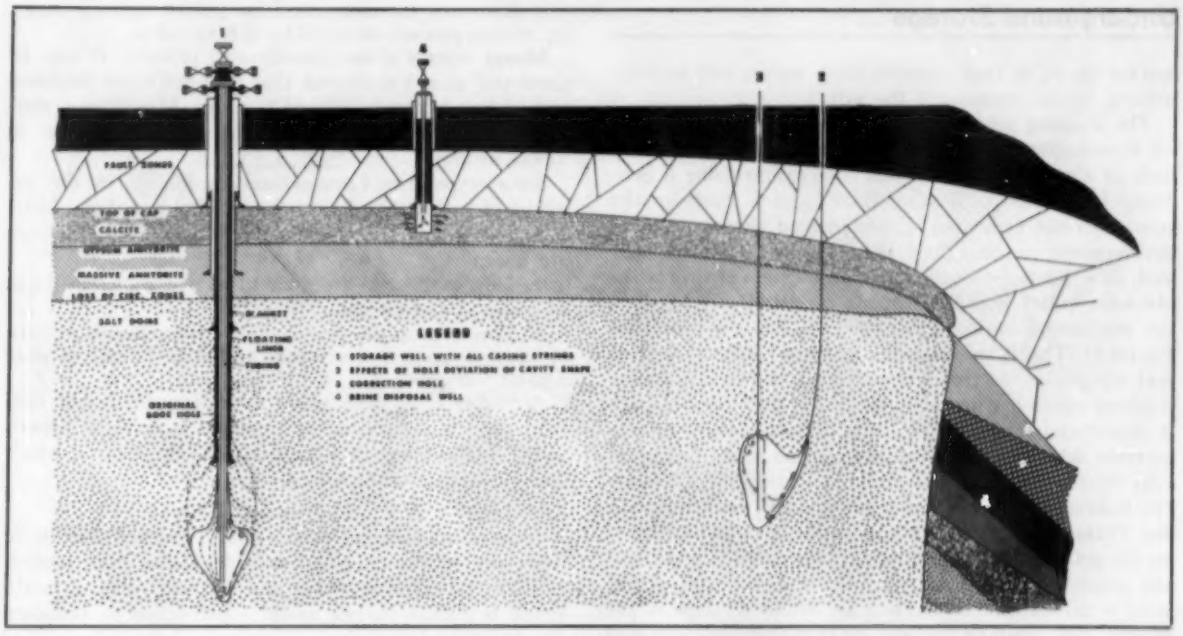

FIGURE 3—Details of salt dome storage wells

are washed in one operation, though the lower sections will be developed to lesser extent than the first soluble formations encountered. This method has particular advantage in areas where thin salt sections only are available, or in other areas where it is desirable to develop only one section (of an existing series of salt layers) which may lay between two heavy impervious geological members.

Certain disadvantages may also be attributed to this particular washing procedure and, since these disadvantages are critical, careful study should be given to the particular storage well in question and, if the disadvantages outweigh the advantages, other washing procedures should be used. The main disadvantage to top hole washing is the required structural strength of the capping formation. It must be homogeneous within itself, must be thick and impervious. If such is not the case, washing procedures allowing introduction of fresh water immediately under the capping formation will undermine that formation to such a point that it will collapse. It is also evident (see Figure 1) that the peculiar hole shape associated with top washing procedures will allow any caving material to sweep immediately across the bore hole (which exists in roughly its original diameter through insoluble stringers) and as a consequence major troubles will be associated with both removal of the old tubing string and with the attempt to introduce a new tubing string into the hole. Troubles of this nature require a workover of the well. It is extremely difficult to drill through or properly pulverize any obstruction existing across the bore hole, in the funnel shape cavity shown.

As mentioned, the washing will be non-selective and instead of developing storage space in the various soluble sections in advantageous proportions the top soluble section will be developed to maximum extent and the various other sections going toward the bottom will be progressively smaller until little washing action, other than a mechanical washing effect due to velocity and abrasion, will be available at the end of the tubing. Another disadvantage is that possible faults in the capping media may exist at some point remote from the bore hole, such that large lateral development of the top soluble section will result in communication with the fault zone at an indeterminate future date with a consequence of the complete storage chamber being rendered unusable.

Bottom hole washing techniques are of a similar nature as far as casing and tubing programs are concerned; the basic change being the fact that fresh water is introduced down the tubing with salt water returns through the casing. Less stringent requirements on the capping formation may be allowed and some progressive development of exposed soluble sections may take place (see Figure 1). Since the fresh water is lighter than brines contained in the hole, it will have a tendency to rise until it hits the first impermiable section. At that time it will flow to the original bore hole, go through that bore hole, rise across the second soluble section and thence through the bore hole into the next insoluble section etc., and thus to the undersurface of the main capping media.

It can be seen by this method that progression of developed space will now be from bottom to top, that is, the bottom chamber will be larger, the second chamber slightly smaller, etc. This method has the disadvantage of being inefficient, in that more time will be required to bring the brine up to saturation, because of the very fact that fresh water will float and will have no mechanical means (for example, displacement pressure movement) of being forced into contact with all surface areas of the soluble material. After sufficient salt surface area has been developed to maintain complete saturation of the recovered brine, the further disadvantage still exists that flow rates must be kept within the limits of those

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surface areas, so that valuable fresh waters will be fully utilized in the removal of the salt.

The washing procedure which probably has the greatest advantage and utility, consists in running an auxiliary liner to a predetermined depth (this casing string is generally known as a "floating liner" and is hung in the tree—it is not cemented) depending on proposed cavity development, running the tubing string through this liner and, as a further precaution, introducing a hydrocarbon blanket (either butane, propane or diesel oil) between the production casing string and the floating liner (see Figure 1). This is known as the "Trump" blanket method and was utilized in the recovery of salt brines in a similar washing operation in the early 1900's. Sufficient blanket is introduced into the hole such that only those soluble sections desired may be washed at one time. Extension may thereby be accomplished in one section and by lifting the floating liner to a higher section and re-introducing the Trump blanket, the second section may be developed to the point desired, the floating liner again is lifted and the procedure repeated. The main disadvantages attributed to this method of washing are similar to those of the bottom hole washing method, in that washing rates and washing efficiencies are limited until salt surface areas are developed. It does, however, constitute the most careful type of washing operation and should be utilized when conditions are unfavorable in the capping formation and in the insoluble stringer configuration.

A further washing procedure is used in areas where only thin sections of soluble salt are available for use (see Figure 2). This procedure utilizes two wells drilled in close proximity such that a lateral development of one of them, by procedures previously discussed, will eventually communicate with the bore hole of the second and thereafter fresh water will be pumped in one well with returns from the other. This method may only be utilized if the capping formation is of an impervious nature and has extremely high structural strength. It is also a method that can be resorted to in the event that an already existing well were to become dangerous to operate because of stringer failure. For example, the second well could be drilled and washing procedure carried on through it with returns through the original well to the surface. Product injection and withdrawal would be carried on in reverse direction to the washing schedule.

Past

The underground storage idea is not new, having been proposed as early as 1919. Underground storage was practiced, in effect, a considerable time before that when protective blankets were placed in brine wells.

Some early attempts were made to store LPG in depleted oil sands. The value of this type storage is extremely dubious. Recovery experience has been bad and product recovery must be reprocessed.

Some experiments have been carried on with LPG flotation in anticlines. These show great possibilities, since anticlines exist in almost unlimited number throughout the world. Several disadvantages are evident:

1. It is hard to determine the limits of the anticline.
2. It is an ideal hydrocarbon trap and small quantities of oil or gas are generally present.
3. Recovery experience can be gained only by usage, i.e., testing procedures could be of little value.

Mined storage shows considerable promise. It may be developed in any type rock that is of sufficient thickness and of low permeability and porosity. Most mined storage is in shales. First experiments were carried on in Texas, in 1950.

Some experiments have been conducted in the removal of hydratable shales via a drilled bore hole. Little is known about this type of operation. Two problems are basic:

1. How to disperse the shale to such a point that it can be removed economically.
2. How to stop the dispersal once the required volume of storage space is developed, and it is desired to store and recover product.

Attempts have been made to utilize abandoned railroad tunnels. More can be expected from these experiments. Many interesting problems do exist, most of which have been successfully solved.

Present

It is estimated that some 11.277 million* barrels of underground storage was available in the early part of 1955, in the United States and Canada, with an additional 6 million barrels under construction or proposed for the year.

It is unfortunate that salt bodies are mainly in producing areas and as a consequence the majority of storage exists there. This is clearly a fallacy in proper utilization since product must still be delivered to consuming centers.

Present emphasis is being placed on the development of storage in marketing areas of the country. Several advantages will thereby accrue:

1. Tank car fleets can be utilized to the maximum extent. The economics involved in idle tank cars, loss of mileage, etc., associated with high volume seasonal movements are indeed startling.
2. Flexibility in movement of production from plants at various geographical locations to the most practical destination is considerably improved.
3. A large volume chamber of specification product, established in a marketing locality, can permit accelerated expansion of connected loads and be an extremely valuable sales angle in that expansion.

Since many marketing areas are not blessed with salt deposits, considerable work is being done in storage in anticlines, mined shale, mined hard rock, abandoned tunnels and prestressed concrete pipe.

Future

Some basic thought should be given to the orderly expansion of an industry that marketed 122,238,000 barrels of LPG in 1954, and which is constructing facilities that will produce some 5 million barrels additional in the year to come. Most of this product is being marketed on an unrealistic marketing system of $1\frac{1}{2} = 1$. The industry has vast undeveloped domestic markets; an industrial demand increasing due to new research in motor fuels and further utilization of LPG as primary fuel (in concentrated population centers); and a petrochemical industry that continues to make expansion in facilities, techniques and processes based on assured LPG supply.

The situations exist that if new markets are to be exploited, if new and untapped areas are to be adequately serviced, a base of supply sufficient to assure the ultimate

* This figure does not include approximately 2 million barrels of storage in oil or gas sands.

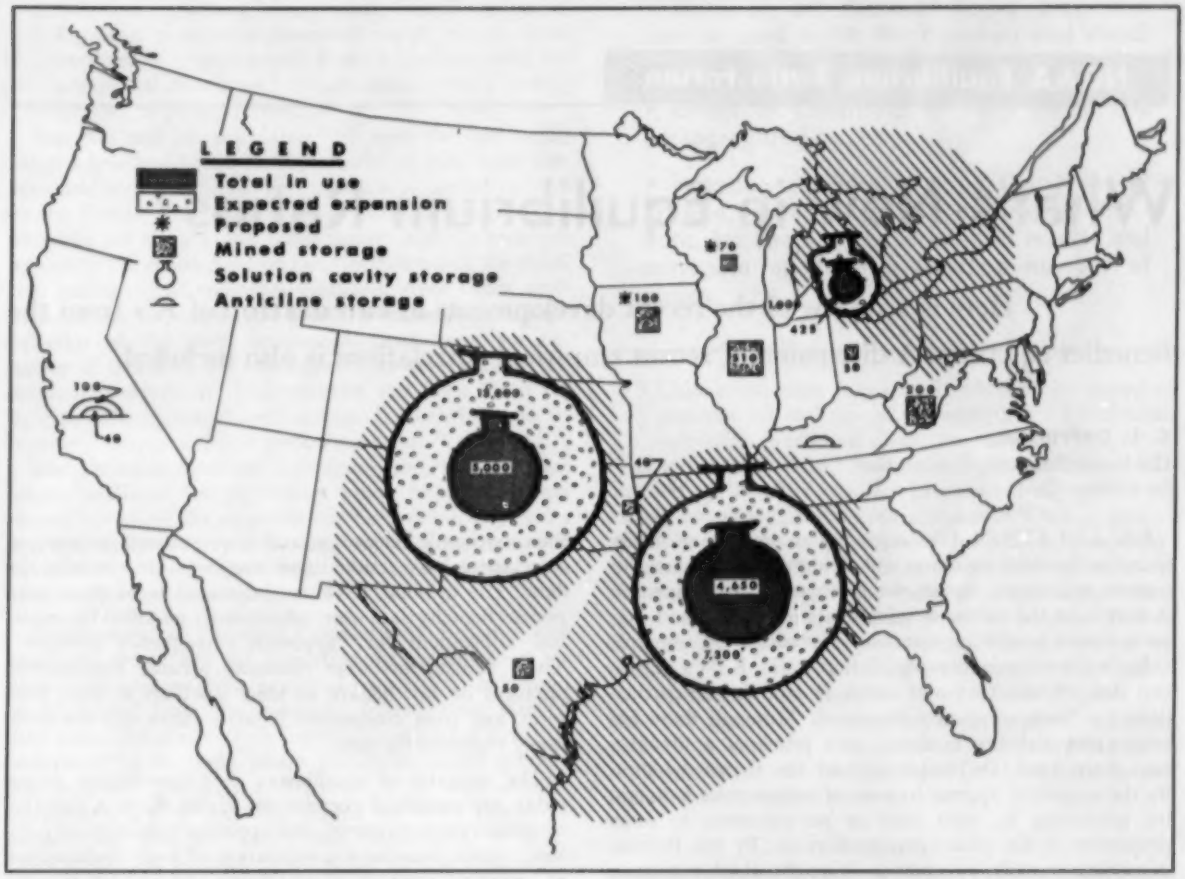

FIGURE 4—Status of underground storage for the 1955 season (estimated in thousands of barrels)

consumer of uninterrupted service, with quality product at a reasonable price, is an absolute necessity. Large supply volume chambers seem to be the basic solution, and underground storage chambers seem now to be the only economical answer.

Some persons in the industry have stated that large underground storage capacities are the cause of the unstable price situation that now exists. It is generally felt, however, that those facilities instead will eventually tend to stabilize the price of LPG and further will allow the distributors serviced by such storage to expand their businesses without fear of overselling and consequent deterioration of customer relations.

It is quite paradoxial that the development of underground storage is but temporary relief to the old problem of supply and demand, and that the development of one such unit begets the necessity of another, ad infinitum.

This discussion, in placing special emphasis on washed solution chambers in salt sections, does not attempt to specify that type underground storage as the answer to the problem. Large portions of the U. S., Canada, and Mexico are sufficiently removed from salt bodies that servicing of such areas must be accomplished by other types of underground storage. It is the author's feeling that the major percentage of large volume storage developed in marketing areas of the future will be of the mined type.

It should also be emphasized that large scale underground storage appears to be beyond the realm of economic practicability for the local distributor, and that storage other than steel surface tanks must be developed to fit his need for larger volume chambers. Prestressed concrete pipe in large diameter, arranged in some logical pattern and buried a short distance underground, shows considerable promise. The estimated cost for this type storage is $15 per barrel, a considerable percentage of this amount being involved in freight, excavating, backfilling, and manifolding on the pipe itself. Under ideal conditions this unit cost might be reduced to $7.50 per barrel and with revision of manufacturing techniques, for special application to this field, the unit cost might be further reduced. It is quite evident, however, that this method can have little advantage to the producer, because of his need for super-storage, since initial costs would be prohibitive.

A systematic program of exploration, research and development on all known types of containing media and investigation of all new techniques of storage processes must be carried on with vigor and imagination if the LPG industry is to hold its place in the sun.

This discussion is condensed from its original presentation before the annual meeting of NGAA, April 13-15, 1955, Dallas. ##

NGAA LPG Forum

What's New in Equilibrium Ratios?

Here is a review of the recent developments in calculation of K's from the Benedict equation. A discussion of recent empirical correlations is also included.

C. L. DePriester,
California Research Corporation,
La Habra, Calif.

CALCULATION OF vapor-liquid equilibrium ratios from the Benedict equation will yield greater accuracy for many applications, though the calculation time is greater. A review of the recent developments in this method suggests several promising directions for additional research.

Since the vaporization equilibrium ratio, $K = y/x$, was first defined, accuracy and utility of equilibrium correlations has been constantly improved. Although there has been great diversity in detail, two principal approaches have been used, the empirical and the thermodynamic. By the empirical approach, a set of simple rules is sought for predicting K, with little or no reference to other properties of the phases in equilibrium. By the thermodynamic approach, an equation is sought which represents all thermodynamic properties of the phases, including the fugacity. Equilibrium ratios can be calculated from fugacity by the relation:

$$K_i = y_i/x_i = \frac{f_i^L/x_i}{f_i^V/y_i}$$

in which f_i^L and f_i^V are fugacities of component i in the liquid and vapor phases respectively.

In the development of working correlations, both approaches have resulted in important contributions. Typically, the direction of investigation has been indicated by thermodynamic reasoning, and improvements in working correlations have resulted from empirical treatment of the data. The original K-values calculated from pure component fugacity data were subsequently modified by empirical adjustment for "apparent convergence pressure." These adjustments were necessary because hydrocarbon mixtures do not behave as ideal solutions at high pressures, and pure component fugacity ratios did not accurately represent the data.

The majority of equilibrium data correlations in use today are empirical correlations giving K as a function of temperature, pressure, and apparent convergence pressure, which correlates composition effects. Investigation of empirical methods is continuing and important work based on convergence pressure has been reported in recent years by Winn,[18,19] Hadden,[8,9] Rzaza, Glass, and Opfell,[14] and Organick and Brown.[12] Correlations of this type are widely accepted because the presentations are simple, broad ranges of temperature, pressure, and composition are covered, and accuracy is sufficient for many engineering calculations.

Although available correlations had great utility, many investigators sought improved correlations for the following reasons:

1. Insufficient K-value accuracy for certain calculations
2. Disagreement between correlations and lack of rational basis for selection of the best values
3. Uncertainty of extrapolation and interpolation to conditions not covered by experimental data.

The Benedict Equation—Characteristics of an equation for representing thermodynamic properties had been derived from classical theory. For calculating vapor-liquid equilibrium in hydrocarbon mixtures, an equation for fugacity is required that is continuous throughout the fluid region and includes phase composition effects. Preferably, a fundamental equation should be derived from which all thermodynamic properties can be calculated by purely mathematical operations. Advantages of an equation of this type are:

1. Data on all thermodynamic properties can be used to fit the equation and check final form.

Meet the Author

C. L. DEPRIESTER, a research engineer with California Research Corporation since 1948, currently is assigned to study secondary recovery problems. He joined the company shortly after he received his master's degree in chemical engineering from the University of Michigan and as an initial assignment, he began research in natural gasoline plant operation, including absorber-design methods, absorption oil and light hydrocarbon equilibrium vaporization ratios, distillation column design and gas dehydration. He is author of an article published in *Applied Thermodynamics*, part of the Chemical Engineering Process Symposium series.

2. Effect of conditions in each phase can be segregated.
3. Equation provides a consistent set of criteria, independent of experimental K-data, for checking experimental results and extrapolating from a limited number of points.

Benedict and his associates[1, 2, 3, 4] were the first to develop a practical equation for behavior of light hydrocarbons and their mixtures. The equation is similar in form to the Beattie-Bridgman equation of state. Independent variables are density and temperature, and the equation applies to the entire fluid region. Coefficients of the equation include eight constants evaluated from vapor pressure, critical constants, and pressure-volume-temperature behavior of the pure component. Coefficients for behavior of mixtures are calculated from constants for individual components. The equation has been fitted for light paraffin hydrocarbons, methane through heptane,[1, 11] benzene,[13] nitrogen,[17] and carbon monoxide.[16]

The Benedict equation is probably the most accurate means available for predicting phase behavior within ranges for which the equation has been fitted. It is not a practical method for the working engineer because each calculation is an involved trial and error solution of a complicated nonlinear equation.

Development of Practical Correlations—Benedict and associates recognized the limitations of the equation for direct use, and sought a practical correlation that could be calculated from the equation. Investigation showed that composition effects on fugacity coefficients could be correlated by the bulk phase parameter molal average boiling point. Fugacity coefficients, f^L/x, and activity coefficients, f^V/Py, were calculated for wide ranges of temperature, pressure, and phase composition, At pressures up to 1000 psia, the liquid phase activity coefficient, f^L/Px, and reciprocal of vapor phase activity coefficient, Py/f^V, were shown on a series of constant pressure charts as functions of temperature and molal average boiling point of the respective phases. The equilibrium ratio is the product of the two functions,

$$K = \frac{f^L/Px}{f^V/Py} = \frac{f^L/x}{f^V/y}$$

This correlation, with additional charts showing fugacity coefficients at pressures from 1000 psi to 3600 psi, was published on the "Kellogg charts".[10] These charts retained most of the accuracy of the Benedict equation and were much simpler to apply.

DePriester[5] developed a compact presentation of the same fugacity functions on pressure-temperature-composition charts for the 0-1000 psia range. Each of the functions f^L/Px and Py/f^V is shown on a single chart for each component for pressure from 0-1000 psia and the same ranges of temperatures and phase compositions included in the Kellogg charts. In addition, pressure-temperature nomographs were developed to show average K's for use in preliminary calculations. The DePriester charts are as accurate as the original presentation for the range of conditions covered, and have the following practical advantages:

1. Complete pressure range is represented on one chart.
2. Interpolation for liquid composition is continuous.
3. Minor inconsistencies were eliminated by smoothing methods used to develop the charts.
4. Number of charts was reduced to two for each hydrocarbon.

• Data on all thermodynamic properties can be used to fit the equation and check final form.

• Effect of conditions in each phase can be segregated.

• Equation provides a consistent set of criteria, independent of experimental K-data, for checking experimental results and extrapolating from a limited number of points.

5. Calculation time is markedly reduced by improved presentation and use of nomograph K's for preliminary trials to estimate phase composition.

Edmister and Ruby,[6] using the fugacity functions calculated by Benedict et al for preparation of the Kellogg charts, have developed a generalized correlation of activity coefficients. Activity coefficients for vapor and liquid phases are shown as functions of reduced temperature, reduced pressure, and the ratio of component boiling point to molal average boiling point. Activity coefficients for pressures up to 3600 psia were used in developing the charts. This correlation is the most compact yet developed for presenting the fugacity data calculated from the Benedict equation. Correlation in generalized variables provides a basis for extrapolation and interpolation to estimate values of the functions for hydrocarbons not included in the earlier presentations.

TABLE 1
Average Deviations of Equilibrium Ratios from Experimental Data

Correlation	Number of Points	Average Absolute Deviation, %	Reference
Benedict equation	162	3.4	2
Kellogg Charts: [1], [2]		7.1	6
	257	7.7	6
DePriester PTC Charts	258	6.4	6
Edmister-Ruby	346	6.4	6
DePriester Nomographs	221	15.0	6
Schiebel and Jenny Nomograph [18]	192	17.9	6
N. G. S. M. A. (1951) [7]	218	18.8	6

Evaluation and Summary—A comparison of average deviations of equilibrium ratios predicted by methods based on the Benedict equation with other correlations is shown in Table 1. The comparisons shown were calculated by Benedict et al.,[2, 4] DePriester,[5] and Edmister and Ruby.[6] The last two correlations listed in Table 1 have been widely used in calculating behavior of light hydrocarbon systems.

This summary is believed to reflect approximately the relative accuracy of the correlations. The Benedict equation and correlations derived from it clearly represent experimental data more accurately than other methods.

"Primary disadvantage of methods based on Benedict's work is the limitation in range of applicability. The methods are accurate for light paraffin hydrocarbon systems at pressures up to 360 psia."

Equilibrium Ratios . . .

Table 1 is not an exact comparison because experimental data used in computing the deviation summaries were not the same for all correlations, ranges of conditions covered by the correlations vary, and there is no way to accurately determine the effect of experimental uncertainties. The average deviation shown for the Benedict equation was computed for data from 12 investigations believed to be the most reliable in the literature at the time. The other comparisons all include additional experimental data covering wider ranges of composition and perhaps greater experimental error. In Table 1, the last six deviation summaries include multicomponent data not available to Benedict.

Primary disadvantage of methods based on Benedict's work is the limitation in range of applicability. The methods are accurate for light paraffin hydrocarbon systems at pressures up to 3600 psia. Molal average boiling point satisfactorily correlates the effects of molecular characteristics of paraffins and olefins insofar as can be determined by comparison with presently available data. Additional work is necessary to extend coverage to include mixtures containing aromatic, naphthenic, and high molecular weight paraffin hydrocarbons. The effects of including hydrogen, nitrogen, carbon-dioxide, hydrogen sulfide, and other nonhydrocarbons should also be investigated, and extensions of temperature and pressure coverage would also be highly desirable.

In present form, these methods cover a highly useful range of conditions, and are valuable additions to the engineer's basic data. Calculation time is greater than for previous methods, but is justined by greater accuracy for many applications.

Presented at the NGAA convention in Dallas, April 15, 1955.

NOTATION

f = fugacity
K = vaporization equilibrium ratio
P = pressure
x = mole fraction in liquid
y = mole fraction in vapor

Subscript

i = component i

Superscript

L = liquid phase
V = vapor phase

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More About Equilibrium Ratios . . .

Equilibrium Ratio Charts Soon: The Natural Gasoline Association of America, which has had the policy for years to make available to engineers and chemists the latest information on equilibrium ratios, is about to publish an extensive and useful set of equilibrium ratio charts. The publication is a joint contribution of Dr. G. G. Brown, Dean of Engineering, University of Michigan, and The Fluor Corporation, Ltd., edited by NGAA's new subcommittee on equilibrium ratios. The new work represents a logical extension of earlier NGAA efforts such as the "Ideal" equilibrium ratios published in 1951 in the Engineering Data Book of Natural Gasoline Supply Men's Association, a joint editorial effort of the NGAA and NGSMA.

A group of more than 100 charts is to be published together with a short introductory text explaining how to use the charts. The subcommittee selected this system of charts because they satisfied these criteria: simplicity in form and ease of use, broad range in temperature, pressure and composition, and satisfactory accuracy relative to that of other charts now available, for many routine engineering applications. ("Equilibrium Ratio Charts for Hydrocarbon Systems," E. I. Organick, United Gas Corporation, Shreveport, La.)

Partial Enthalpies: There are two principal methods for finding partial molal enthalpies, one, by calculating from other thermodynamic properties of the mixture, and the other, by calorimetric measurements. If extensive PVT and phase equilibrium data are available for a binary mixture it is possible to calculate by means of thermodynamic relationships the partial molal enthalpies of each component of the mixture and this has been done for a few mixtures. It is not practical to handle multicomponent mixtures in this fashion because of involved interrelationships resulting when more than two components are present. On the other hand, certain equations of state have been shown to predict thermodynamic properties of mixtures, both the partial properties and the total mixture properties, fairly accurately, and one of these equations of state has been used to estimate partial molal enthalpies even in multicomponent mixtures.

Because phase equilibrium data are related thermodynamically to enthalpy data, there seems to be a promise that at least the partial latent heat of vaporization of a component could be estimated from the equilibrium vaporization ratio (K) curves.

Calorimetric determinations of partial enthalpies are also filled with difficulties. For practical reasons, experiments are limited to binary mixtures. The experiments may be of a Joule-Thompson type where a fluid is expanded adiabatically from a higher to a low pressure, measuring the temperature change and the phase change, if any, to get the data for calculating enthalpies. Or measured quantities of heat may be added to a mixture under controlled conditions to obtain the data for calculations. In any event, the experimental technique is difficult and the results of the calculations are more inferential than direct. ("The Need for Partial Molal Enthalpies," Karl Hachmuth, Phillips Petroleum Co., Bartlesville.) ##

Tioga Plant Accounts for Weather

This North Dakota absorption plant is designed for outside temperatures varying from —30 in the winter to 100 in the summer.

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Signal Oil & Gas Company,
Los Angeles

LOCAL CONDITIONS can sometimes present the biggest challenges in the design of natural gasoline plants. Weather conditions, including humidity, average temperatures, means and extremes of wind and rain, were of particular concern in the plant at Tioga, N. D.

Tioga is located approximately 70 miles east of the Montana border and 40 miles south of the Canadian border, where the closest communities of any size are Williston, 50 miles west, and Minot, 85 miles east.

The climate is quite variable and runs to extremes. Temperatures of 30 degrees below are not rare in the wintertime and as high as 100 degrees in the summertime. Actually, the extremes registered at Williston show five months have record temperatures below —30 and an extreme of —50 F. There are also five months with record temperatures above 100 degrees and a maximum of 110 F. The yearly average temperature is 40 degrees, with five months of the year that average below 30 F., or freezing. Winds from the southeast prevail in the summertime and from the northwest during the winter.

With this background, it was decided that the gas should be dehydrated before absorption, thus making it possible to operate the absorption plant free of freezing materials, or water. As long as the absorption cycle was free of water and water vapor and the plant was operated on a 'dry' basis it was decided to leave all of the process equipment out-of-doors, or at least the pump equipment and tower bases would not have to be housed to protect them from the hazards of 'freeze-ups.' Also, it was not necessary to steam trace and insulate many of the lines that would otherwise contain water or water vapor. It should be possible under these conditions to permit temperatures of condensers and other equipment to fall below freezing. Too, shutdowns could be made without danger of freeze-ups. In order to maintain this as a dry plant it was, of course, necessary to operate the distillation unit on a strictly dry basis.

TABLE 1
Gas Analysis

Separator Temperature:	SUMMER 80 F.		WINTER 30 F.	
COMPONENT	Mol. %	GPM	Mol. %	GPM
Carbon Dioxide	1.259	.....	1.347	.....
Nitrogen	1.399	.....	1.496	.....
Hydrogen Sulfide	2.883	.....	2.962	.....
Methane	57.577	.....	61.387	.....
Ethane	16.690	.....	17.311	.....
Propane	10.405	2.846	9.895	2.707
Iso-Butane	1.658	.539	1.292	.420
Normal Butane	4.060	1.273	2.838	.890
Iso-Panthane	1.213	.441	.587	.213
Normal Penthane	1.038	.374	.446	.161
Hexanes	1.282	.524	.337	.138
Heptanes Plus	.536	.268	.102	.051
Total	100.000	6.265	100.000	4.580
Propane at 90 Percent	.....	2.561	.....	2.436
Excess Butanes	.....	.947	.....	1.007
25 lb. Gasoline	.....	2.472	.....	.866
Total	.....	5.980	.....	4.309

The combination of temperature, wind, and moisture is also responsible for storms of varying natures. When blizzards occur here the snow is whipped by winds so that visibility is reduced to almost zero. Since all of the pumping equipment, regulators, and controlling equipment were to be placed out-of-doors it was necessary to have a control room where all of the operating conditions could be controlled and observed under the worst weather conditions. In addition to actual control equipment and necessary flow rates, many other operating temperatures and pressures were transmitted to the control room, in order to aid the operator in observing plant conditions.

A second factor to be given consideration was the lack of water in sufficient quantity for adequate cooling. Water wells drilled in the area have small production capacity and in addition, the water requires treatment. Because of this condition aerial units for cooling and condensing are used in all services. The use of water has been restricted to the control of critical services for only such periods as required to maintain reasonable operations during warmest air conditions.

A third factor also related to weather is the content of the wet gas available to the plant. Since the extremes of temperature at the lease separators materially affect the content of the gas entering the plant, the richness varies over a considerable range in the twelve-month period. The high propane content of the gas, as shown by analysis, made it economical to consider a high percentage extraction of propane. Being also an area of relatively low temperature, it was expected that the market demand for this product would make it desirable to design

for a recovery of 90 percent of the propane. (See Table 1.)

In order to recover 90 percent of the available propane, which was desired, large volumes of ethane and methane were also absorbed at 750 pounds. Approximately 12 percent of the wet gas entering the absorber was found to be dissolved in the rich oil. Thus, approximately 7000 mcf of ethane and methane is discarded in the deethanization of the rich oil from the top of the reabsorber for plant fuel use.

With aerial condensing the degree of deethanization is important during the warmest weather. Inclusion of much ethane in the raw product accumulator would make total condensing difficult during periods when the atmospheric temperature was above 90 degrees. This also precludes the use of vapors or gases for stripping in the distillation unit.

Absorption—Design conditions for the plant are based on 65 Mmcf of field gas at plant intake being raised to 750 pounds gage pressure for absorption. Gas is purified of H_2S and CO_2 at the first stage discharge and dehydrated at third stage discharge, before absorption.

Shrinkage through the above units, removing acid gases and condensibles, reduces the amount of wet gas to the 750 pound absorber to approximately 58 Mmcf. In order to extract a high ratio of propane, and heavier, it was desirable to keep the temperature rise through the absorber at a minimum. For this reason the wet gas to the absorber is commingled with the oil from the 28th (bottom) tray of the absorber and passed through an aerial cooler to remove the heat of absorption of the heavy ends.

During summer temperatures the lean oil circulation approximates 375 gpm. Under this condition this so-called 'equilibrium tray' at the bottom of the absorber accounts for 4,900,000 Btu per hour in absorbing the heavy hydrocarbons. The combined material is returned to the base of the absorber where the gas is separated to continue through the trays to the top of the absorber.

There are also two intercoolers in the absorber flow design, one below the 6th tray and the second below the 16th tray, for removing heat of absorption from the contacting oil stream. The upper intercooler is expected to remove approximately 755,000 Btu per hour and the lower intercooler, 930,000 Btu per hour. The removal of this amount of heat during the absorption process makes it possible to maintain maximum absorption capacity with a minimum of oil circulation. Also, effective column capacity is not reduced by internal reflux conditions.

The rich oil from the base of the absorber is further enriched by adding the pressure condensate which has been dehydrated. This rich oil stream is then 'flashed' at 300 pounds gage in the rich oil flash tank.

Rich Oil Rectification—The rich oil rectification is accomplished in two tower sections, one a deethanizer column and the other the reabsorber section. The deethanizer section consists of 20 trays. The rich oil feed to this column includes the rich oil from the high-pressure flash tank and the rich oil stream from the base of the reabsorber. This combined oil stream is preheated by exchange with lean oil before entering the top of the deethanizing column.

The oil arriving at the base of the deethanizing column is picked up by circulating pumps which pump the oil from the base of the column through heat exchange, or reboiler, against the hot lean oil from the still.

The oil and flashed vapors are returned to the base of the column where the vapors rise through the 20 trays against the down-flowing rich oil, to the top of the column. The heat transfer in the reboiling section is designed for 42 million Btu per hour.

The vapor stream from the top of the deethanizing column is joined with the vapors from the 300 pound rich oil flash tank. This combined vapor stream is then joined with the rich oil from the bottom tray (33rd) of the reabsorber. This stream then passes through an aerial cooler or 'equilibrium tray' similar to the bottom cooler on the absorber to remove the heat of absorption. It is then returned to the bottom of the reabsorber where the resulting gas and vapors are separated to flow up the reabsorber column. The heat of absorption at the base of the reabsorber approximates 1.5 million Btu per hour. The rich oil leaving the reabsorber is pumped in with the rich oil from the 300 pound rich oil flash tank to the top of the deethanizer column. As mentioned previously, this oil is heated through exchange with the lean oil before entering the top of the deethanizing column. The preheating of this rich oil removes some 12.5 million Btu per hour from the lean oil.

The combination of these two columns is designed to be able to remove ethane and lighter hydrocarbons from the rich oil stream, and to retain all of the propane and heavier hydrocarbons. The propane that leaves in the vapor stream from the deethanizing column is in turn recovered in the reabsorber section and returns with the refluxing oil. A single column operation has actually been divided into two columns.

Sufficient of the lean oil stream is put over the reabsorber to economically prevent loss of propane in the resulting vapor leaving the reabsorber section.

In order to make this reabsorber an efficient column there are also provided intercoolers for removing the heat of absorption at the 13th and the 23rd trays. The heat removal here is about 1.1 million Btu per hour at each cooling unit. These are actually 7 and 17 trays, respectively, from the top of the reabsorber section. The top 6 trays are a presaturating section for the lean oil that is used in the main absorber. At the presaturator, the heat of absorption of methane and ethane, which is approximately 2 million Btu per hour, is removed from the oil before it enters the main absorber. Also, this absorbed quantity of dry gas is carried to the 750-pound stage and in consequence reduces the amount of gas that is necessary to be used at the 250-pound pressure level.

Distillation—The rich oil from the base of the deethanizer column goes directly to the feed tray of the still,, which is the 16th tray. Since there is a reduction of pressure here from approximately 250 pounds (deethanizer) to 100 pounds gage on the still, there is some flash at this feed tray.

The down-flowing oil is removed after the 21st tray

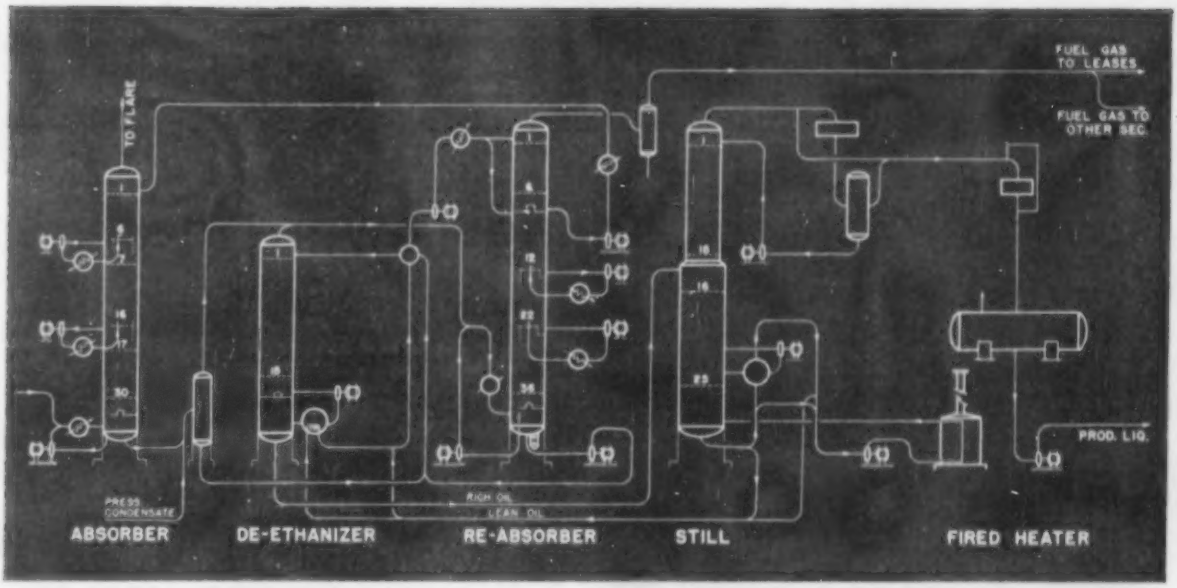

FIGURE 1—Flow diagram of plant: Designed for 90 percent propane recovery.

and circulated through heat exchange transferring 33 million Btu per hour with lean oil from the bottom of the still, to provide a controlled temperature gradient at this point of the column. With a 'dry' distillation, still performance is dependent upon the introduction of sufficient heat to remove all gasoline fractions from the oil and to carry them overhead in vapor form, in the same manner as a fractionation column. Heat is introduced at the bottom of the still by circulating the oil from the bottom tray through fired heaters. In order to maintain a low temperature rise of the oil, about three gallons of oil are circulated to the furnace for each gallon of actual lean oil circulation used in the main absorber and reabsorber.

This high circulation makes it possible to introduce a high Btu quantity, partly of latent heat at lower outlet temperatures than would result if the same amount of heat at lower circulation rates were to be used.

Total heat load requirements for distillation from the fired heaters is 50 million Btu per hour. An additional 25 million Btu fired heater is provided for heat requirements in the fractionating section of the plant and other plant heating loads. Hot oil circulation is used to avoid the use of steam.

Since the maximum still loading is encountered during summer periods when the gas is richest with heavy hydrocarbon content, the still design was based on this condition.

As a result, future expansion of distillation capacity may be obtained by removing the pressure condensates from the oil stream. This would reduce the hydrocarbon content of the rich oil to the amount of hydrocarbons in the gas entering the absorber only. By stabilizing the pressure condensates separately, the distillation unit is relieved of handling this hydrocarbon content. By removing the pressure condensates and treating them in this manner, the still is able to handle the equivalent hydrocarbon content by treating additional wet gas volumes.

Control of the end point of the hydrocarbon product is made by refluxing back heavy gasoline fractions from the primary condensers. The unit operates totally condensing.

Stabilizing or separation of the final products is straightforward. Propane is produced overhead from the first column, with all butane and heavier as feed to the second column, where butanes are removed overhead and natural gasoline is produced as a kettle product. The heat load, as menitoned previously, is supplied by a hot oil circulation from a fired heater.

Original presentation was before the annual meeting of NGAA, April 13-15, 1955, Dallas.

ACKNOWLEDGMENT

Acknowledgment is given to J. F. Pritchard and Company, of Kansas City for the design and engineering of the Tioga Plant and to Brown & Root of Houston for the construction.

More on Economics . . .

Package Plants: Two factors today make vest pocket gasoline plants an attractive investment: conservation laws and the price of natural gas. To fulfill its purpose, no matter what recovery system is adopted, a vest pocket plant will have to be designed to recover a fairly high percentage of the available gasoline from the gas being processed. At the same time, the over-all cost must be low for both installation and operation, and the unit should have high salvage value. If by such an installation, oil and gas can be produced from wells heretofore shut in, or more oil can be produced from wells from which production has been restricted because of a limited gas outlet, the plant may be a good investment even though it does not pay its way. ("Vest Pocket Gasoline Plants," R. B. McLaughlin, Northern Natural Gas Company, Omaha, Neb.). ##

NGAA Economics Forum

How to Protect Cooling Tower Headers

Two years of testing show that protective coatings can control corrosion of piping headers to cooling towers and reduce the maintenance expense.

R. L. Elkins and G. O. Hult,
Shell Oil Company,
Midland, Texas

PROTECTIVE COATINGS, if applied properly and in sufficient film thicknesses, will control corrosion of piping headers to cooling towers. Shell Oil Company has reached this conclusion after extensive tests—tests that were commenced when atmospheric corrosion of these piping headers in gasoline plants showed up as a major problem. In applying such coatings, however, it is believed necessary to use comprehensive specifications together with good supervision and inspection. Greatly reduced maintenance costs have been chalked up as a result of this procedure.

The history of paint coatings in this service is one of short coating life and unsatisfactory corrosion protection. For example, at the time the TXL Gasoline Plant was built at Notrees, Texas in 1948, the headers to the cooling tower were coated with a system employing a primer, hot-applied coal tar, and asphalt paper wrapping. The severe operating conditions of high temperature, humid atmosphere, and water spray caused rapid failure of these coatings. Therefore, one year later, in 1949, the coatings were removed, the lines were sandblasted, and a four-coat system of vinyl resin paint applied. During the application of these coatings the tower remained in service and the lines were shielded from water spray with tarpaulins. Again relatively rapid coating failures occurred and corrosion proceeded at a fairly high rate.

When an addition was made to the plant in 1949 a second cooling tower was added and all headers to this tower were painted with a two-coat system of cold-applied coal tar. Once more rapid coating failures occurred. These and similar experiences in Shell's other two gasoline plants in West Texas indicated that the problem was of sufficient importance to merit a careful study of corrosive environments and possible control methods. Therefore, a thorough investigation was made in 1952 and it was decided that, in spite of the poor performance of previous coatings, the use of protective coatings was still the most promising method of preventing corrosion of headers in service.

Since the protection of replacement headers or headers in newly constructed towers is a problem which is quite different in many respects, the application of coatings may not be the most practical method of protecting them. Due to the hazardous conditions existing in the vicinity of the cooling towers, only the cold-applied coatings were considered suitable for coating headers in service; thus metallizing and other similarly applied coatings were excluded. In order to improve the performance of coatings applied to piping headers, it was concluded that better paints and application techniques were needed.

This investigation also indicated that the highest corrosion pitting rates generally occurred on the outlet headers. Apparently, moisture condensed and collected in droplets on the lower half of these lines and produced a deep pitting type corrosion, as shown in Figure 2. When they were examined it was found that many of these headers in the TXL Plant's two cooling towers were pitted almost through their pipe wall even though they had been protected by coatings during a large part of their three and four years of service. Severe corrosion pitting also had occurred on many of the inlet headers

Meet the Authors

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G. O. HULT, who is Shell's gas engineer at Midland, joined the company in 1936. After a three-year assignment in Oklahoma, he was transferred to Houston, where he stayed until 1951 when he was appointed to his present position as gas engineer for the Midland area. Hult holds a B.S. degree in chemical engineering from the University of Nebraska.

where water ran off the cooling coils onto the line. Several inlet headers in the plant's older cooling tower were deeply pitted due to this cause after four years of service. Another cause of high corrosion rates was water spray which affected principally the lower inlet headers and a section of the upper outlet headers adjacent to the coil flanges, as shown in Figure 3.

In view of the need for improved paint performance, comprehensive specifications covering cleaning and application methods were prepared and during April 1953 the piping headers to the two cooling towers in the TXL Plant were again coated, this time with several types of paints in accordance with the specifications. Briefly, the specifications stated that:

(1) The contractor would furnish all supervision, labor, transportation, insurance, rigging, cleaning material, and sandblasting and coating equipment to perform in a workmanlike manner all cleaning and coating work in strict conformity with the specifications.

(2) Surfaces would be protected from all water spray during the process of sandblasting and subsequent application and drying of coatings.

(3) All surfaces to be coated would be thoroughly clean of rust, dirt, oil, grease, old paint and mill scale by sandblasting to a Class A white steel surface finish. Note: Class A white steel surface finish required the complete removal of all corrosion products, loose and tight mill scale and the gray oxide binder between the mill scale and steel, thus exposing the white metal.

(4) Sandblast sand would be dry, angular or sharp flint or silica abrasive type and would be properly graded (100 percent of which would pass a No. 10 mesh sieve and 95 percent of which would be retained on a No. 20 mesh sieve) and free of clay or other matter likely to become imbedded in the steel surface.

(5) The compressed air used in sandblasting would be free of oil and would have a sufficiently low moisture content to prevent condensation of moisture on the surfaces being cleaned.

(6) Prior to the formation of corrosion, all sandblasted surfaces would be cleaned dust-free by wiping with clean cloths, or vacuum cleaning and immediately primed. Should the prepared surface become dirty or rusty before the prime coat was applied, the surface would be resandblasted.

(7) Where painting had commenced, the complete painting operation, including priming and finishing coats, would be completed as soon as possible. In no event, except delay due to weather conditions, would more time elapse between successive coatings than that necessary to render the coats thoroughly dry.

(8) In applying the coatings, the spray gun would be held not more than 6-8 inches from, and at right angles to, the work at all times. A wet-looking film that would flow, but not to the point of sagging, was desired. Air pressures on material pot and spray gun would be controlled to provide a uniformly wet film.

(9) The performance of work and the finished coating would be subject to inspection by an agent of Shell and additional coatings would be applied, if necessary, to all areas where vinyl or epoxy resin paint films were less than 5 mils, or phenolic resin paint films were less than 20 mils thick.

Competitive bids were obtained and the low bidder performed the work. The headers were shielded from water spray with tarpaulins and corrugated metal during the course of cleaning and painting, and the work was performed while the tower was in operation. Shell's plant engineers inspected and made certain that the performance of work and the quality of the finished coatings met specifications.

In this coatings test a five-coat vinyl resin system, employing a primer and four top coats, was applied to 47 outlet lines and 46 inlet lines with operating temperatures ranging from 80 to 150 F. For comparative purposes some of these systems utilized a wash primer and others used a red lead primer. However, comparisons to date have not revealed any noticeable superiority of one primer over the other. In addition to vinyl, a four-coat epoxy ester resin system, employing a red lead primer and three top coats, was applied to 27 outlet lines and 27 inlet lines operating at temperatures from 80 to 240 F. Both the vinyl and epoxy paints were spray-applied without reducing the normal operating temperatures of the lines, and no paint blistering or other difficulty was encountered. This was of interest in view of the fact that four of the lines coated with vinyl paint had operating temperatures as high as 150 F., and eight lines coated with epoxy paint had temperatures of 240 F. Measurements of the completed paint systems showed that a minimum dry film thickness of 5 mils had been obtained with both the five-coat vinyl and the four-coat epoxy systems.

In addition to these tests, a three coat system of an amine-cured, modified phenolic resin paint was brush-

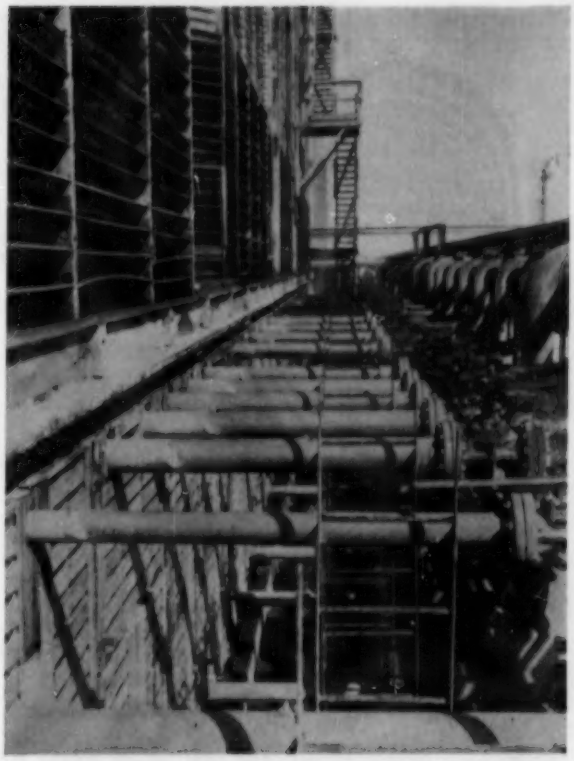

FIGURE 1—Coated piped headers to cooling tower: Note white scale due to water spray and evaporation.

Even better results might be obtained by using knowledge obtained from these tests, by more strict conformity to specifications and by minimizing water spray on coated headers.

FIGURE 2—Outlet piping header shows severe corrosion pitting.

applied to two outlet and four inlet lines with operating temperatures from 80 to 240 F. This system consisted of a primer, containing powdered mica, and two top coats. An attempt was made to apply the paint to the hot lines; however, brushing difficulties demanded that they be cooled during the painting process. Measurements of the coated lines indicated that a minimum film thickness of 30 mils had been obtained.

During the two years since the headers were coated they have been examined periodically and few coating failures have been observed. The coatings on almost all of the outlet headers, where the corrosion problem was most severe, are still in excellent condition. For example, coating failures have occurred on only seven of the 76 outlet headers. In every case these failures were adjacent to the cooling coil flange and had been caused by severe water spray, as shown in Figures 3 and 4. Failure consisted of only a few small coating breaks per line. Coating failures on the inlet headers have been more numerous, occurring on 21 of the 77 lines. However, extensive failures have occurred on only two of these 21 lines, while the remaining 19 contain but a few small coating breaks per line. Blistered paint coatings on inlet lines are shown in Figure 5. Here again failures were attributed to severe water spray. In an effort to protect the paint coatings, water spray on headers was reduced, or eliminated, where possible, and this practice seems to have been very beneficial in prolonging the service life of the coatings.

Comparisons of vinyl and epoxy resin coatings to date have revealed no significant differences in their performance. The epoxy paints have performed very well on 240 F. lines where the vinyl paints likely would have failed rapidly. The top coat has peeled in places on these high temperature lines coated with epoxy; however, the three remaining coats are intact and providing protection. Since this has not occurred on any of the cool lines, the peeling is believed to have resulted because the high temperature caused rapid paint drying, and too much time elapsed between the application of the third and fourth coatings. For these reasons the paint dried to a hard finish and poor adhesion between these coatings resulted. So far the epoxy systems have shown an economic advantage due to the fact that 5 mils minimum film thickness was obtained with four coats of epoxy paint whereas five coats of vinyl were required. In addition, somewhat greater coverage was obtained with the epoxy paints, as shown in Table 1. For these reasons the epoxy systems required less material and labor which was reflected in their cost of $0.65 per square foot versus $0.81 for the vinyl systems.

The modified phenolic coatings are still in excellent condition and appear to be particularly well suited for use on the high temperature lines. These coatings on four 240 F. inlet lines have exhibited no blistering, peeling or checking even though they have been subjected to heat, water spray, and severe scaling conditions. The scaling

FIGURE 3—Coated outlet header shows paint blistering adjacent to cooling coil flange due to water spray.

FIGURE 4—Splash zone on outlet and inlet headers. Coatings are still in good condition.

FIGURE 5—Coated inlet headers show paint blistering due to severe water spray.

FIGURE 6—High temperature inlet headers show heavy accumulation of scale.

condition is very destructive to coatings because the scale continually cracks off and tends to remove the coating in the process. Figure 6 illustrates the type of scale accumulation on these lines. As shown in Table 1, the phenolic coatings cost $1.11 per square foot, or almost twice that of the vinyl or epoxy coatings. However, it appears that this higher cost will be justified in instances where high temerature and severe water spray are encountered.

Cost analyses which have been made indicate that substantial savings will be effected by these protective coatings. For example, it was estimated that the average life of unprotected piping headers to the TXL Plant's two cooling towers would be about four years. This was based on the findings of severe corrosion damage to many of the headers after three years service, a large portion of which time they had been protected. Assuming an average four-year life, the annual cost of replacing piping headers to the two towers would be about $5600 per year. In contrast, it cost $3030 to coat all of these headers. If the epoxy and vinyl resin coatings last three years and the phenolic resin coatings last four years, which appears very likely, the yearly cost of protection will be $990, or only 18 percent of the cost of uncontrolled corrosion.

TABLE 1

Costs of Epoxy Ester, Vinyl, and Modified Phenolic Resin Paint Systems

PAINT RESIN	No. of Coats	Coverage (Ft.²/Gal.)	Materials Cost ($/Ft.²)	Labor Cost Cleaning & Coating ($/Ft.²)	Total Cost of Coating System ($/Ft.²)
Epoxy	4	193	0.168	0.482	$0.65
Vinyl	5	150	0.267	0.543	$0.81
Phenolic	3	117	0.684	0.423	$1.11

In summary, the performance of the test coatings is much improved over that previously obtained, and this improvement is attributed to the use of definite specifications. It is believed that even better performance might be obtained from coatings applied in the future by using the knowledge obtained from these tests, by requiring more strict conformity to specifications, and by minimizing water spray on coated headers. In view of the results to date it appears that protective coatings, if applied properly and in sufficient film thicknesses, can be employed to control corrosion of piping headers to cooling towers, and thereby greatly reduce maintenance expense. In order to assure the quality of the coatings, it is believed necessary to use written, comprehensive specifications together with good supervision and inspection when applying paints in such corrosive environments as found in cooling towers. Finally, if headers are painted, steps should be taken to reduce, or eliminate, water spray on them since this procedure will greatly lengthen the life of the coatings.

Original presentation was before the annual meeting of NGAA, April 13-15, 1955, Dallas.

NGAA Corrosion Forum

Cut Corrosion in Dehydration Unit

Control program reduced corrosion in the rich glycol solution, the lean glycol solution and in the dried gas line of this gas dehydration unit.

Will Swerdloff and Maryann Duggan,
Magnolia Petroleum Company,
Dallas

MAGNOLIA PETROLEUM Company has disclosed experience obtained from more than five years of combatting corrosion in a diethylene glycol gas dehydration unit. Results show:

- Corrosion has been reduced in the rich and lean glycol solutions and dried gas lines.
- While corrosion test coupons may indicate the effectiveness of controls, inspections are necessary to determine how equipment has been affected.
- Continuous attention to the details of the control program is needed for maximum benefits.

Description of Installation—The dehydration unit, which started operation late in 1947, has a typical flowsheet, as shown in Figure 1. The diethylene glycol solution passes from the contactor through the heat exchangers to the reactivator where it is stripped of absorbed water so that the glycol can be returned to the contactor after being cooled by the heat exchanger and after-cooler. Typical temperatures and pressures are:

	Temp F	Pressure, Psia
Gas to contactor	85	600
Gas from contactor	88	
DEG from contactor	87	
DEG to regenerator	170	
DEG from regenerator	340	3
DEG to contactor	110	

The dehydration unit follows four stages of gas compression. The natural gasoline absorber is at the end of the first stage. All equipment in the original glycol unit was carbon steel. The gas to the dehydrator is sour, as is indicated by a recent analysis of non-hydrocarbon components:

H_2S	58 Gr/100 SCF
Mercaptans	54 Gr/100 SCF
CO_2	1.36%

This analysis is representative of the gas throughout the corrosion control program.

Difficulties Because of Corrosion—In June, 1949, first indications of difficulties because of corrosion were noted. The solution filter elements required frequent change because of accumulation of iron sulfide compounds, about 7 pounds of such material being removed each week. The filter elements required change about every seven to nine days. Glycol solution began to accumulate in the gas scrubber section beneath the contactor trays. The unit was shut down and inspected. The reactivator was fairly clean with little apparent corrosion. Some, but not excessive corrosion appeared on both the rich and lean sides of the exchangers. Considerable deposits of iron sulfide had settled out in the heat exchangers. The contactor showed severe corrosion. There were scattered pits about ⅛-inch deep. Contactor trays were 10 gage carbon steel. The most severely damaged portion of the contactor was in the chimney tray which divided the inlet gas separation space from the contactor trays and in the first two trays.

In December, 1950, the dried gas line blew out about 80 feet downstream from the contactor. This was schedule 40, 4-inch pipe that had been in service about four years. In May, 1951, a rupture occurred in one of the dried gas meter runs. This was a schedule 40, 6-inch pipe that had been in service about four years.

Corrosion Control Program—In 1949, when troubles were first noticed, there began an investigation of the glycol solution. The pH of the solution ranged from 4.1 to 5. One analysis showed 0.035 weight percent H_2S and 0.018 weight percent CO_2. The pH of an entrained liquid sample was 3.6.

In September, 1949, after success with stainless steel coupons, the contactor was equipped with a stainless steel lining and stainless steel trays. The material was 25-20 Type 310 stainless steel.

In October, 1949, prior to the blowout in the dried gas line, a program was started using 50 ppm of Inhibitor A in the glycol solution. Inhibitor A is a 45 percent solution in water of sodium mercaptobenzothiazole. Together with this inhibitor, caustic was added to maintain the pH of the solution at about 8. While this may have given some protection to the cold DEG solution, as is indicated in the accompanying figures, this method of protection was stopped several months later because of the high consumption of caustic by acidic components in the gas.

In January, 1951, as causes of the corrosion were sought, several conditions were noticed: (1) The temperature of the gas to the contactor was excessive. It was thought that if this temperature were lowered the chemical reaction producing the corrosion would at least be slowed down. (2) It was found that glycol entrainment

was excessive. If the glycol were the cause of the corrosion, it was reasoned that corrosion rates could be lessened by reducing the quantity of glycol entering the dried gas line.

As a result of recommendations, an additional gas cooler upstream from the dehydration unit was placed in operation in late March, 1951. This gave a drop in gas temperature of about 20 F., the temperature being reduced from 100 to 80 F. A dried gas scrubber was installed in May, 1951. These changes gave benefits.

The use of one percent of Inhibitor A in the glycol solution was started in June, 1951. This was added to the solution hold-up of the system and then to drums of make-up glycol. At present, 2000 cc of the inhibitor is added to the system twice each month. The volume of glycol contained in the unit is 450 gallons.

In October, 1951, a system was installed to decrease the presence of oxygen in the gas stream. This consisted of admitting higher pressure gas into the low pressure inlet gas line whenever the suction pressure of the compressors dropped to one psig. Contamination with oxygen was difficult to confirm since it was not present at all times. The oxygen content of the gas was confirmed on the sample with the mass spectrometer. The concentration of oxygen in the gas is related to the presence of vacuum in the gathering system.

These measures decreased difficulties resulting from the presence of the glycol in the dehydration unit and in the dried gas line.

In October, 1952, the injection of Inhibitor B (polyethanol rosin amine type*) was started into the dried gas line. The inhibitor is injected at the rate of 0.1 gallon.per day. The gas volume is 6000 mscfd. The inhibitor can be diluted with kerosine to increase the volume for pumping. Figure 2 shows the injection equipment. The nozzle is ¼-inch pipe cut off at 45 degrees, installed to meet the gas flow. The lubricator used for pumping is powered by the glycol circulation pump. The inhibitor coats the pipe. If an excessive amount is injected it may coat the surfaces to an undesirable extent.

Coupon Results—The effects of the steps taken to decrease corrosion can be discussed better by referring to the attached figures. These plot the corrosion rate versus time and also show the length of exposure for each of the corrosion coupons. The flow sheet, Figure 1, gives the coupon exposure conditions and their locations.

Figure 3 shows the corrosion rates of carbon steel coupons exposed to the rich glycol solution in the base of the contactor. The first coupon results are from exposures starting about November, 1949, when 50 ppm of Inhibitor A was being added and the pH was adjusted to 8 with caustic. Here the corrosion rate was about 7 to 9 mils per year. The coupons show that when this treatment was stopped the rate climbed to about 23 mils per year. When the temperature of the gas was dropped, oxygen eliminated and the higher percentage of Inhibitor A used, the corrosion rate decreased and approached one mil per year from about the beginning of 1952 up to the present. The figure shows rises and falls in the corrosion rates experienced by the coupons. One reason for this may be variations in the effectiveness of the oxygen elimination program.

* A 70-percent solution in isopropyl alcohol of a mixture having the proportion of 90 percent of ethyloxylated rosin amine (11 moles ethylene oxide reacted with each mol of rosin amine) and 10 percent free rosin amine.

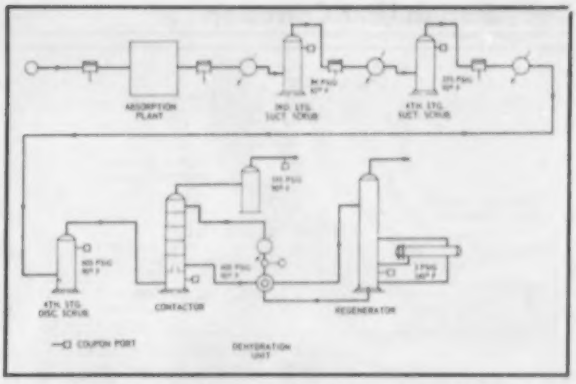

FIGURE 1—Gas flow and dehydration unit flow diagram.

Figure 4 shows the effect of the treatment on coupons exposed to lean glycol in the base of the regenerator. The coupons exposed here show corrosion rates as high as 24 mils per year about the beginning of 1950. The spread of results also show that the hot solution is much more susceptible to variations in conditions. While we might say that the coupon corrosion rate has declined to about 2 mils per year, at the present, it is apparent that there has been much more variation in these results than in those obtained in the rich glycol.

Figure 5 shows the corrosion rates for coupons exposed to the dried gas. This curve may remind one of a sine wave. Fortunately it has a downward trend. It is of interest that the corrosion rate in this line has declined

Meet the Authors

WILL SWERDLOFF, chief of the Economics & Development section for Magnolia Petroleum Company's Natural Gas department, has been with the company since 1940. Previously associated with Phillips Petroleum Company's Natural Gasoline department, he spent his first six years with Magnolia in its Field Research department, where he was in charge of process design and economic studies and finally head of the Development section which also included pilot-plant operations. He is a University of Kansas graduate and holder of several patents in hydrocarbon processes. He is chairman of the Dallas AIChE section.

Swerdloff

MARYANN DUGGAN, recently appointed as director of Magnolia's Technical Library and Information Center, joined the company in 1945 as a chemist in the Field Research laboratories. After four years in various research and development assignments, she was appointed to Corrosion Technical Service work, which she continued until named to her present position. A graduate from North Texas State College, she is a member of NACE, ACS, AAAS and the Texas Academy of Science.

Duggan

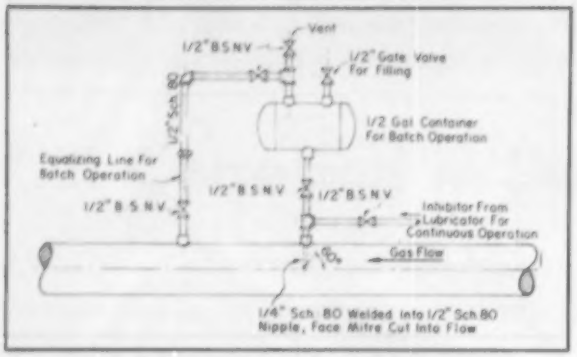
Vent
1/2" BSNV
1/2" Gate Valve For Filling
1/2 Gal Container For Batch Operation
Equalizing Line For Batch Operation
1/2" BSNV
1/2" BSNV
1/2" BSNV
Inhibitor From Lubricator For Continuous Operation
Gas Flow
1/4" Sch. 80 Welded into 1/2" Sch 80 Nipple, Face Mitre Cut Into Flow

FIGURE 2—Batch or continuous injection of corrosion injection is possible with this set-up.

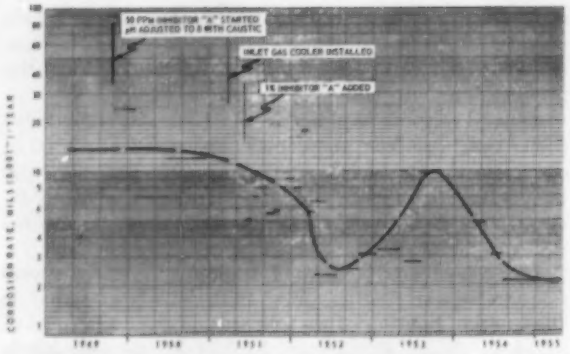

FIGURE 4—Hot lean glycol solution coupon corrosion rates.

from around 30 mils per year to a present rate of 0.2 mils per year. Even the last peak of 1 mil per year is a great improvement over the original rate. The benefits obtained in the glycol solution are reflected in these coupon results. The figure shows that the use of the cooler and one percent of Inhibitor A in the glycol gave a decline to perhaps 7 mils per year in the corrosion rate at this site. When air was eliminated more effectively the rate dropped to about 3 mils per year. The peak about the middle of 1952, we believe, was caused by the entry of additional air. When the use of Inhibitor B was started about November, 1952, the drop in the corrosion rate is spectacular to about 0.2 mils per year. The next peak after these good results, about the middle of 1953, caused an investigation which showed that insufficient amounts of Inhibitor B was being added. Instead of 0.1 gallon per day, 0.025 gallon was being added. When the rate of addition was corrected the corrosion rate dropped to 0.3 to 0.4 mils per year. The next peak, about the middle of 1954, was caused by oxygen entering with the gas again. The last result, 0.2 mils per year, is what was obtained with effort being made to eliminate the oxygen and inject inhibitor at the correct rate. This figure shows the attention that must be given to the details of a corrosion control program to obtain the maximum benefit. The Inhibitor B also stopped hydrogen blistering of the coupons.

Figure 6 shows the corrosion rates of coupons exposed to the gas upstream from the dehydration unit. At those locations there never have been any failures because of corrosion. For this reason it had been thought that all the corrosivity imparted to the gas was related to the dehydration unit. The upper curve shows coupon corrosion rates for the gas to the dehydrator. These coupons

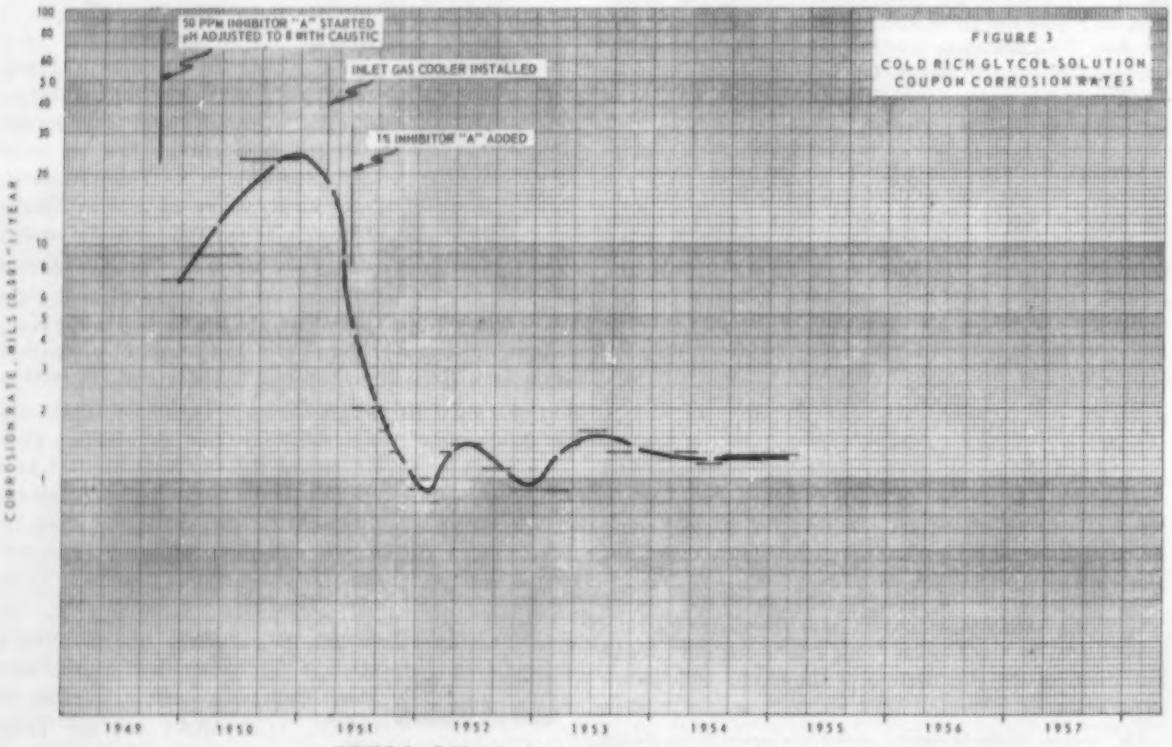

FIGURE 3—Cold rich glycol solution coupon corrosion rates.

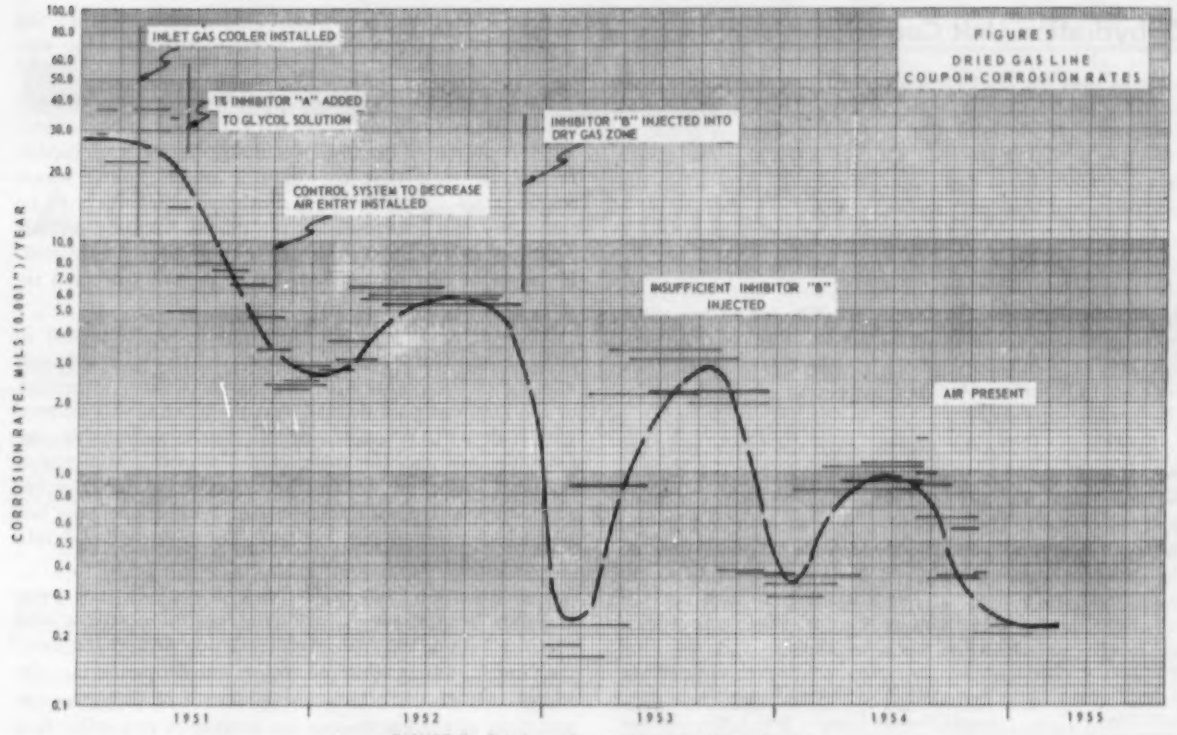

FIGURE 5—Dried gas line coupon corrosion rates.

were exposed in the compressor discharge scrubber. The coupon results in the fall of 1951 show rates of about 25 mils per year. Coupons exposed through most of 1954 show rates of about 9 mils per year. These are indeed high. While we may have had some effect on the corrosivity of this gas by decreasing the presence of oxygen, it can also be noted that the lower coupon results are for coupons exposed for a greater period of time. These latter coupons were exposed for periods that approach a year, whereas the initial higher results are coupons exposed for two-to-three-month periods. When the interior of this scrubber was inspected it was found that all exposed parts were covered by a heavy, black scale. The gage readings as are shown in Table 1 gave almost original thickness for this vessel which was installed in 1939. Knowing these results, it may be said that these coupons corrode rapidly until a protective coating of corrosion products is formed. If the initial higher rate is deducted from these coupons, the net corrosion rate is about 6 mils per year.

The corrosion rate of coupons exposed to the hot fourth-stage discharge, 190 F., was negligible, 0.1 mil per year. This shows that a water phase is necessary for the corrosion reaction.

The middle curve shows coupon results for the fourth-stage suction scrubber. Here, too, there is a decline from about 16 or 17 mils per year to about 10 mils per year. Here again we may say that the corrosion forms a protective coating.

The bottom graph shows results for coupons exposed to the third-stage suction scrubber. Here it appears that coupons exposed for a longer period of time gave increased corrosion. Gage results, however, do not bear this out.

These coupon results are of interest in that they show that coupons themselves cannot be used as the final measure of the effect of a corrosion control program. It is also of interest that the coupon results for this lowest pressure location are lower than those for the higher stages. This probably is the effect of decreased partial pressure of the carbon dioxide at the lower pressure.

After Corrosion Control—In May, 1951, the interior of the contactor was inspected. The stainless steel lining and trays all were in good condition. This agreed with results for stainless steel coupons of 0.1 mil per year. The 2-inch glycol feed line was also replaced and cut into 2-inch long pieces. These showed slight corrosion. Inside diameters varied from 2.062 to 2.067 inches. The nominal id of schedule 40, 2-inch line is 2.067 inches.

Late in 1951 the glycol solution which had been black with iron sulfide became a reddish-brown color similar to lube oil.

In January, 1952, the glycol cooler was inspected and cleaned. It contained a thick deposit of black iron sulfide. An 18-inch section of fins at the hot inlet end showed corrosion. The first two inches were gone. The corrosion became less severe until it was very slight at 18 inches. This inspection is of interest in that this equipment had operated since late 1947 during the time when corrosion was severe and into the time when corrective measures were taken.

In March, 1955, the glycol heat exchanger was inspected. Several leaking tubes were plugged and it was

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evident that the heat exchanger will require retubing or replacement in the near future. This is additional evidence that the inhibition of the hot solution is not as effective as that of the cold. Of course the heat exchanger has operated almost eight years and at the time when the corrosion had been very severe.

In October, 1952, the regenerator was inspected. Some corrosion was found but not to a severe extent. Pits in the manway cover were 1/32 to 1/16-inch deep and 1/4 to 3/4-inch in diameter. The trays are 10-gage carbon steel. Some pits were also evident on the walls. Since this vessel operates at about atmospheric pressure, effects of corrosion are not severe. Another inspection is scheduled for the coming summer.

In March, 1952, the fourth stage discharge scrubber was inspected, as previously mentioned. A black deposit 1/8-inch thick was present on the manway cover plate and vessel walls. The cover plate was cleaned and one pit 5/64-inch deep and 1-inch in diameter was found. One pit 1/4-inch in diameter by 1/64-inch deep was found in the wall area that was inspected. This is evidence that the product of corrosion forms a protective covering upstream of the dehydration unit.

TABLE 1
Thickness Gauge Inspections

LOCATION	No. of Points Inspected	Date Installed	Thickness Gage Results			Original* Thickness
			Avg.	Max.	Min.	
6" Dried Gas Line	52	1947	0.243"	0.253"	0.233"	0.241"†
Contactor & Scrubber Piping	20	1953	0.278	0.280	0.276	0.280
Scrubber Walls	7	1952	0.941	0.953	0.930	0.875
3rd Stage Suction	5	1939	0.278	0.278	0.276	0.25
4th Stage Suction	5	1939	0.680	0.687	0.671	0.6875
4th Stage Discharge	6	1939	1.059	1.067	1.053	1.0625

* Nominal or print dimension. † One location.

Table 1 gives thickness gage inspection results for various locations. Only one set of data obtained in November, 1954, is presented because of a change in the gage model. It can be seen that corrosion is small. Points where readings are greater than the original thickness may be caused by mill tolerances on the plates. Additional readings must be obtained to determine the rates of corrosion. However, it can be concluded that the rates are not severe, at least for the points tested.

The contactor and scrubber piping was replaced in 1953, because thickness readings could not be obtained at some of the points with the thickness gage. Inspection of the removed pipe showed that the interior was covered with a deposit. When the deposit was removed the gage gave an average thickness of 0.272-inch. Micrometer readings based on an outside diameter of 6.625-inches gave an average wall thickness of 0.277-inch. This line had been installed late in 1947. The pipe had a 0.280-inch wall thickness.

Conclusions—Thus it has been shown (1) that progress has been made in reducing corrosion in the rich glycol solution, the lean glycol solution and in the dried gas line; (2) that while corrosion test coupons may give indications of the effectiveness of control programs, inspections of the equipment are needed to determine how it has been affected by the treatment; (3) continual attention must be given to the details of the program to receive maximum benefits.

Original presentation was before the annual convention of NGAA, April 13-15, 1955, Dallas. ##

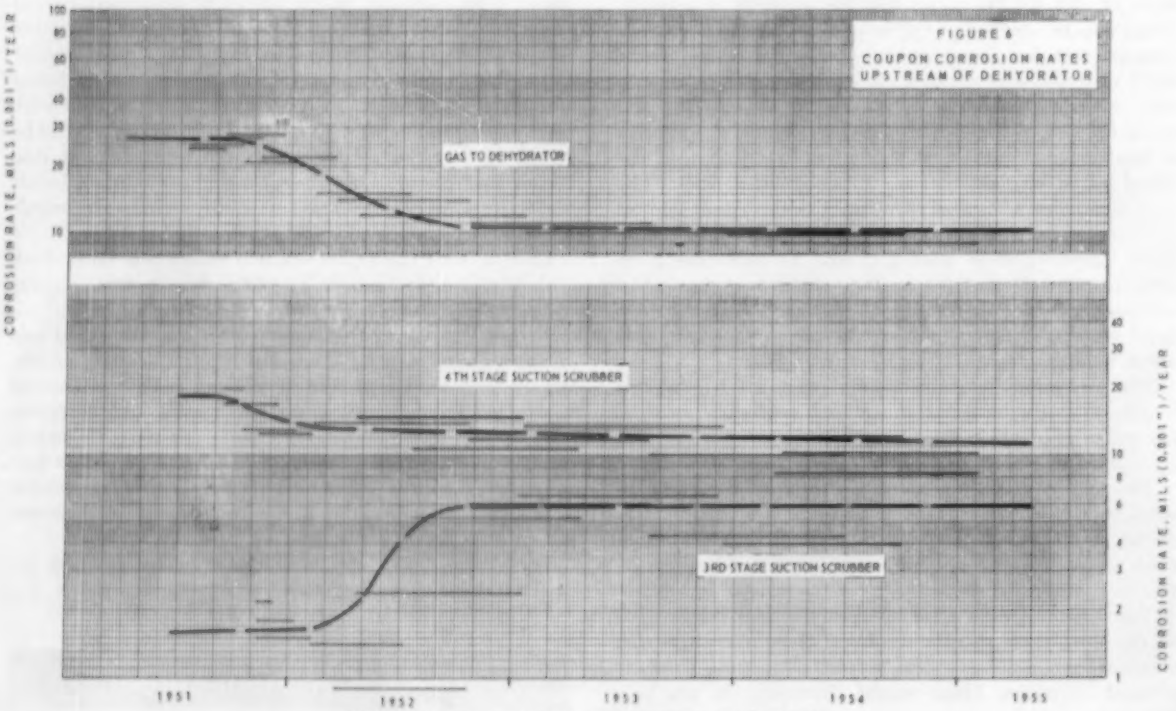


FIGURE 6—Coupon corrosion rates upstream of dehydrator.

A Case History in Plant Corrosion

Here's how two gasoline plants used organic inhibitor treatment and the injection of alkaline boiler blowdown water to raise the pH of acidic waters.

W. M. Kyger and G. L. Shepherd,
Arkansas Fuel Oil Corporation,
Shreveport, La.

DURING THE PAST four years, internal corrosion of steel pipe, pressure vessels, and other equipment in contact with sweet natural gas and hydrocarbons has been detected at the East Texas and Panola plants of Arkansas Fuel Oil Corporation. While certain parts of the gas dehydration system at the Panola plant have been protected for about three years, it was only during the year 1954 that steps were taken to broaden the inhibiting program to include a number of points at both plants. Since there is no hydrogen sulfide or other sulfur compounds present in appreciable quantities in the gas or hydrocarbons at either plant, it is presumed that the corrosion is caused by oxygen and carbon dioxide in the incoming gas, combined with water to form corrosive acidic compounds.

At the East Texas plant, located near Greggton, Texas, casinghead gas from oil wells in the East Texas Field is taken under vacuum, compressed from 12 inches vacuum (mercury) in three stages to 400 psig. The gas is passed through an absorber at 400 psig, recovering propane, butane, and natural gasoline. By the aid of mechanical refrigeration more than 95 percent of the propane in the inlet gas is recovered together with substantially all of the butanes and heavier hydrocarbons.

In the early part of 1954 evidences of corrosion which had been noted for some time became serious enough to warrant a survey and, as a result of careful analysis, corrective measures were adopted. The corrosion became evident in the following locations:

1. The gas lines and coolers following the intermediate stage compressors at 250 psig.
2. The gas coolers following the third stage compressors at 400 psig. (In this case, the coolers are G-Fin units where the fins were badly corroded and in many instances had disappeared completely.)
3. Rich oil still reflux partial condensers.
4. Rich oil still final condensers.
5. Depropanizer condensers.

In each of the above systems the corrosion attack was found on both steel and admiralty metal surfaces. The history of tube bundle replacement in the systems is as follows:

1. Condenser No. 1—Admiralty metal tube bundle replaced in 1951.
Condenser No. 2—Several tubes in admiralty tube bundle manually plugged due to corrosion failure.
2. Motor valve body and adjacent piping at bottom of inlet scrubber replaced due to corrosion.
Condenser No. 1—Three sections of admiralty metal tube bundle replaced with carbon steel tubes in 1954. The original tube bundle had been installed in November of 1946.
3. Used condenser with admiralty metal tube bundle installed in 1952. Cleaned with HCl in July of 1953, which removed black deposit causing fouling. No replacement to date.
4. Used condenser with admiralty metal tube bundle installed in 1950. No replacement to date.
5. Condenser No. 1—Inhibited admiralty metal tube bundle installed in 1950. Replaced with inhibited admiralty tube bundle in September of 1953.
Condenser No. 2—Inhibited admiralty metal tube bundle installed in 1951. Replaced with inhibited admiralty tube bundle in February of 1955.

The gas input to the plant was found to contain water vapor, oxygen, and 0.3 percent carbon dioxide. The pH of the condensed water ranged from 4.0 to 6.2. It was

Meet the Authors

Kyger

W. M. KYGER, acting corrosion engineer for Arkansas Fuel Oil Corporation's General Engineering department, joined the company in 1953, after three years with Arkansas Natural Gas Corporation. A natural-gas engineering graduate from Texas A&I College, he serves as a member of NGAA's subcommittee on corrosion.

Shepherd

GLENN L. SHEPHERD has been with Arkansas Fuel Oil as superintendent of processing and design in the Natural Gasoline division since 1948. A Colorado School of Mines graduate, Shepherd has been in the refining and natural gas and gasoline industries since 1926. He has served on the NGAA Absorption sub-committee for four years. Also a member of ACS, Shepherd is listed in *Who's Who in Engineering* and *Who's Who in the South and Southwest.*

concluded from this data that the corrosion was due to CO_2 and acid attack.

Because of oxygen in the system, it was planned to use inhibitor "A," an oil soluble, liquid organic corrosion-preventative, which would prevent rust formation caused by the presence of oxygen. However, as other nearby gasoline plants had experienced a troublesome emulsion from using another inhibitor manufactured by the same company, it was decided to try some other manufacturer's inhibitor. Inhibitor "B," a high molecular weight, polar, hydrocarbon and water dispersible liquid organic inhibitor, was used.

It was known from visual inspection that there was a considerable scale build-up inside the systems. The initial injection program was started below the estimated optimum rate so that the detergent action of the inhibitor would provide a gradual clean-out. The initial dosage of inhibitor was one quart per day at each of the injection points. After a month's operation, the dosage was to be increased to two quarts per day.

Insoluble materials in the kerosine-inhibitor "B" mixture settled out in the bottom of the mixing tanks and pump discharge lines. This caused difficulty in maintaining a constant injection rate, but the trouble was minimized and the injection program carried out. As it was decided not to add mechanical agitation to the inhibitor tanks, inhibitor "A" was injected after the supply of "B" was used up. There is a slight emulsion resulting from the use of inhibitor "A," but it has not yet caused difficulty.

Table 1 presents the dissolved iron content data accumulated before and after treatment. It is evident from this data that the detergent action of both inhibitors cleaned out the systems as shown by the increased iron counts following initial injection. The iron counts remained high throughout the first 60 days of treatment. It was not until the first week in February that the iron counts began to level off at a decreased rate.

TABLE 1

East Texas Gasoline Plant Iron Counts Before and After Treatment (Dissolved Iron Content—ppm)

	SYSTEMS SAMPLED*					
DATE SAMPLED	1	2	3	4	5	6
1954:						
3-30	1.5	100.0	15.0	4.0	NW†	50.0
4-17	3.0	140.0	5.0	1.5	NW	45.0
4-21	0.8	120.0	5.0	6.0	180.0	50.0
5- 6	4.0	10.0	90.0	2.0	NW	40.0
11-22	1.0	170.0	7.5	4.0	7.5	50.0
11-23	4.0	200.0	4.0	4.0	8.0	50.0
	—Treatment started 11-23-54 using Inhibitor "B"—					
11-24	1.2	90.0	8.0	4.0	37.0	NW
12- 1	NW	150.0	8.0	3.0	NW	NW
12- 9	0.8	200.0	4.0	0.4	NW	35.0
12-16	1.0	200.0	6.0	1.0	NW	25.0
12-21	1.0	100.0	6.0	1.0	125.0	NW
12-29	1.2	150.0	12.0	8.0	125.0	NW
1955:						
1- 4	1.5	75.0	3.5	7.5	NW	10.0
1-12	1.5	125.0	5.0	10.0	NW	25.0
	—Treatment changed 1-12-55 using Inhibitor "A"—					
1-13	1.0	100.0	8.0	8.0	NW	25.0
1-28	1.0	232.0	3.0	0.4	215.0	21.1
2- 8	1.0	100.0	5.0	0.4	50.0	20.0
2-15	1.0	38.0	4.0	0.6	NW	20.0
2-21	0.5	75.0	3.0	0.4	60.0	6.0
2-28	0.5	40.0	3.0	0.4	37.5	5.0

† NW—No water suitable for analysis.

* SYSTEM DESIGNATION: 1—250-pound accumulator; 2—400-pound accumulator; 3—Rich oil still reflux partial condensers; 4—Rich oil still water section; 5—Propane accumulator; 6—Raw products surge tank.

A study of three test methods used to determine the corrosion rate provides a preliminary estimate of corrosion reduction. Two of the test methods are by water analysis to determine the dissolved iron and copper content of the condensed water from the various systems. The third test method is by calculation of the actual corrosion rate on thin metal strips placed in the corrosive systems.

A corrosion rate reduction was determined by each of the above methods as shown in Table 2. The reduction in dissolved iron content was determined from the average of the iron counts before treatment compared to the average of the final three iron counts after treatment. The reduced corrosion rate of copper as determined by the dissolved copper content of the condensed water is not conclusive in that a 100 percent reduction in corrosion is impossible, but a definite reduction is apparent. Only one set of coupons has been tested since treatment started. The corrosion rate reduction by this test method was determined by the results of this one test compared to the average of the four sets tested prior to treatment. The percentage corrosion reduction determined by this method cannot be considered accurate without substantiating data from other coupon tests.

Panola Gasoline Plant

The Panola gasoline plant, located near Carthage, Texas, has a capacity of 110 million cubic feet of gas per day. Natural gas from wells in the Carthage Field is processed in the absorbers at approximately 1060 psig and then passed through a dry dessicant type dehydrator before being discharged into the outlet gas pipeline. Mechanical refrigeration is used to increase recovery of products. Condensate from the gas wells is processed at the plant along with the hydrocarbons absorbed from the gas to produce propane, butane, motor gasoline (leaded), kerosine, and diesel oil.

Severe corrosion of ferrous metal equipment was first noticed in the regeneration scrubber of the dehydration system, where the water vapor removed from the gas had been condensed, cooled, and collected. The water drained from the scrubber had a pH of 5.2 to 5.5 and contained about 40 ppm of iron in solution. The corrosion was limited to the cooler outlet, with practically no corrosion being noted at the inlet to the cooler, where the water

TABLE 2

East Texas Gasoline Plant Comparison of Test Data Before and After Treatment

SYSTEM:*	pH	Before Treatment Average	After Treatment Average	Reduction	Percent Reduction
Water Analysis Iron Content:					
1.	5.4	2.4	0.7	1.7	71.0
2.	3.6	123.3	51.0	72.3	59.0
3.	6.5	21.1	3.3	17.8	84.0
4.	4.9	3.6	0.5	3.1	86.0
5.	5.7	65.2	48.8	16.4	25.0
6.	4.9	47.5	10.3	37.2	78.0
Copper Content					
1.	5.4	0.5	....	0.50	100.0
2.	3.6	2.7	2.20	0.50	19.0
3.	6.5	3.7	....	3.70	100.0
4.	4.9	0.4	0.15	0.25	63.0
5.	5.7	....	....	....	....
6.	4.9	1.6	0.60	1.00	63.0
Test Coupons (MPY)					
1.	....	5.93	1.21	4.72	80.0
2.	....	0.33	....	....	....
3.	....	1.07	....	....	....
7.	....	1.39	0.37	1.02	73.0
8.	....	10.00	0.18	9.82	98.0
9.	....	0.22	....	....	....

*SYSTEM DESIGNATION: 1—250-pound accumulator; 2—400-pound accumulator; 3—Rich oil still reflux partial condenser; 4—Rich oil still water section; 5—Propane accumulator; 6—Raw products surge tank; 7—Rich oil still final condensers—outlet; 8—Depropanizer condenser—inlet; 9—Depropanizer condenser—outlet.

was present in the form of a hot vapor. On the line from the cooler to the scrubber and on the water line from the scrubber, the inside of the pipe was etched severely on the bottom.

In 1950 or 1951, the use of inhibitor "C" was initiated to inhibit corrosion in the regenerating cooler, piping, and scrubber. The material is added by means of a "lubricator" type feeder before the cooler at the rate of 1 pint per day in summer and 2 pints per day in winter. Water samples now have a pH of 6 to 7, usually closer to 7, while the iron content is from 1 to 5 ppm. It is considered that the present treatment is protecting the equipment reasonably well.

Also at the Panola plant conditions conducive to corrosion have been noted at the following locations:

	pH of Collected Water
1. Still overhead accumulator	5.5
2. Debutanizer reflux accumulator	5.7
3. Depropanizer reflux accumulator	5.7
4. Deethanizer reflux accumulator	5.7
5. Absorber No. 2	5.7

In each of Locations 1 through 4, corrosion was noted (a) on the ferrous parts of the condensers, (b) in the bottom (inside) of the lines from the condensers to the accumulator, and (c) in the water drain connections from the accumulators. Only the still reflux accumulator has been inspected which showed some internal pitting on the bottom, although the corrosion had not progressed sufficiently to weaken the vessel materially. We are confident that similar conditions exist inside the other accumulators. However, the most severe corrosion seems to occur inside the water drain pipe connections, where the low pH water is concentrated.

In order to arrest this corrosion, it was decided to introduce boiler blowdown water, which is alkaline, and has a pH of 11.1 to 11.5, directly ahead of the condensers in Locations 1 through 4. In Location 5, the boiler blowdown water was pumped into the lean oil stream after it had passed through the rich oil-lean oil heat exchangers and before the lean oil was pumped through the coolers and refrigerated chillers to the absorbers. Calculations indicated that the use of from 5 to 10 gallons per minute of boiler blowdown water would neutralize the acidity at all five locations.

Initial injection of boiler blowdown water was started December 23, 1954. Within four weeks, injection at Location 5 was stopped as the rich oil-lean oil heat exchangers became fouled on the rich oil side. Upon opening the exchangers for inspection it was found that a deposit had formed consisting mainly of sodium chloride and sodium sulfate. The material had precipitated out from the boiler blowdown water when the water vaporized because of the high temperature and low partial pressure.

Injection at the remaining four locations was continued until a newly installed exchanger on the debutanizer overhead stream was plugged with the same material as found in the heat exchangers mentioned above. The following day the injection system was shut down.

The pH in all locations was checked daily and was effectively raised in all systems as shown in Table 3. It is apparent that trouble-free injection of boiler blowdown water in the proper volumes would have maintained a neutral pH. It will be noted that there was a reduction in iron count from 7.0 to 2.5 ppm in the still overhead accumulator. The water volume involved is 14,000 gallons per day. Iron count reduction in the other systems is not known as iron content was not determined prior to boiler blowdown water injection.

TABLE 3
Panola Gasoline Plant
Water Analysis During Injection of Boiler Blowdown Water

DATE	INJECTION LOCATIONS* 1	2	3	4	5
			pH		
1954:	Prior to Injection				
	5.5	5.7	5.7	5.7	5.7
1955:	Injection Started 12-23-54				
1- 3	6.9	....	....	7.0	6.3
1-24	7.1	....	....	7.2	....
2- 8	7.3	....	7.5	7.2	....
2-15	7.3	6.7	7.4	7.2	....
2-28	5.9	6.1	....	6.3	5.9
			Iron ppm		
7-21-54	7.0	....	....	....	....
2-28-55	2.5	170.0	....	20.0	16.0

* INJECTION LOCATION DESIGNATION:
1—Still overhead accumulator; 2—Debutanizer reflux accumulator; 3—Depropanizer reflux accumulator; 4—Deethanizer reflux accumulator; 5—Absorber No. 2.

Other Corrosion Problems

Corrosion in steam lines and condensate return lines resulted in periodic replacement of these lines. A typical analysis of the condensate is as follows: ammonia—4.5 ppm, carbon dioxide—22.0 ppm, and pH—5.8. Organic inhibitor injection into the steam line is being considered.

Cooling water corrosion has been alleviated by the addition of a chromate-phosphate compound and by reducing the pH to a range of 6.1 to 7.0 by the controlled addition of sulfuric acid.

Corrosion of gear boxes in cooling towers is a result of poor coating application and/or poor coatings.

Underground piping is being coated with a cold applied coating with good results on both hot and cold lines.

Crushed limestone, or chat, has caused extensive corrosion of riser piping. The attack was confined to the pipe surface in contact with the chat. Doping and wrapping this section has solved the problem. Pea gravel is being used now instead of crushed limestone.

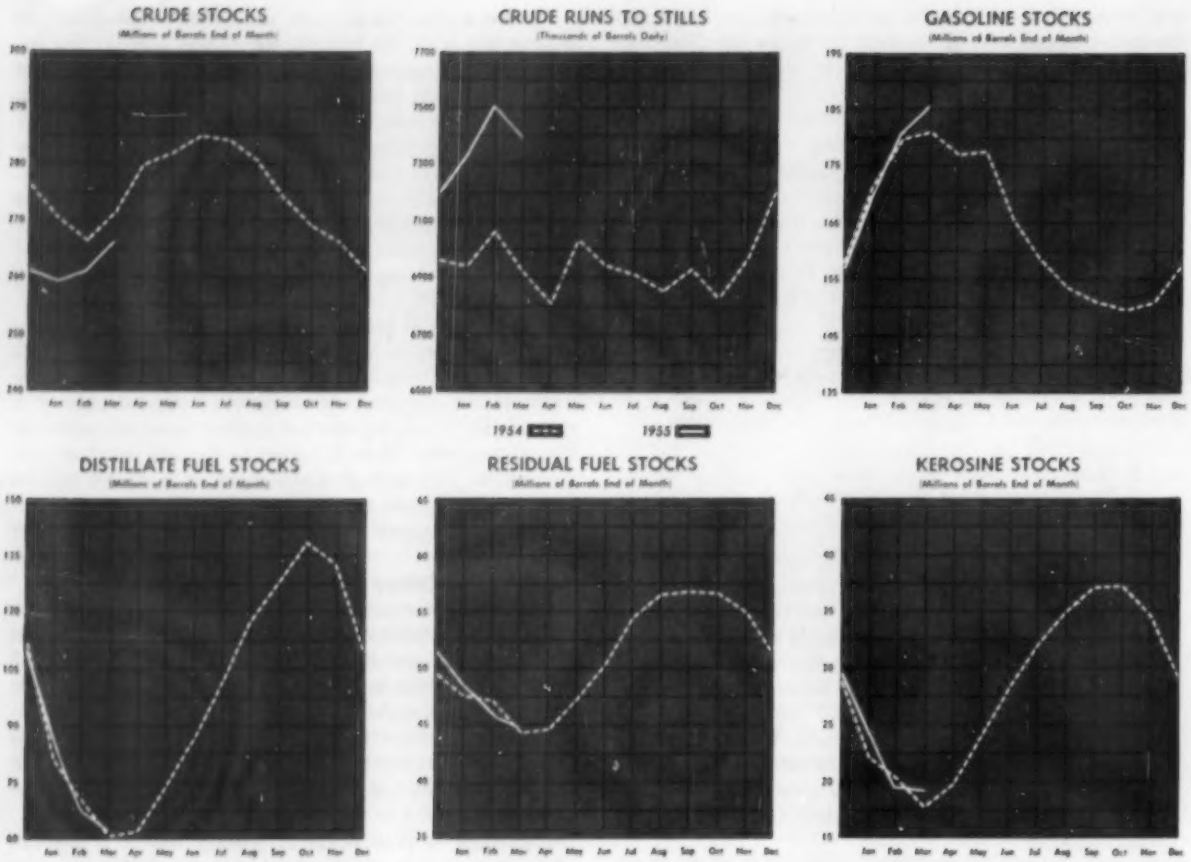
Recently the deethanizer at the East Texas Plant was found to be operating inefficiently. Visual inspection was made and it was found that corrosion products had built up to a level even with the top of the weirs. Half the openings in the bubble caps were covered. Due to this condition on the bottom and top trays, it was assumed the same condition existed throughout the tower.

The tower was cleaned by circulating a chemical cleaning mixture. All of the corrosion products were removed except for a thin scale on the walls of the vessel in the upper section of the tower untouched by the cleaning solution.

The corrosion damage to the tower itself was negligible. There was no visual pitting on the vessel walls or trays. The bubble caps were type 321 stainless steel and had suffered no damage. It is expected that the presently inhibited stream will maintain the clean condition of the deethanizer.

Original presentation was before the annual meeting of NGAA, Dallas, April 14, 1955. ##

NGAA Corrosion Forum



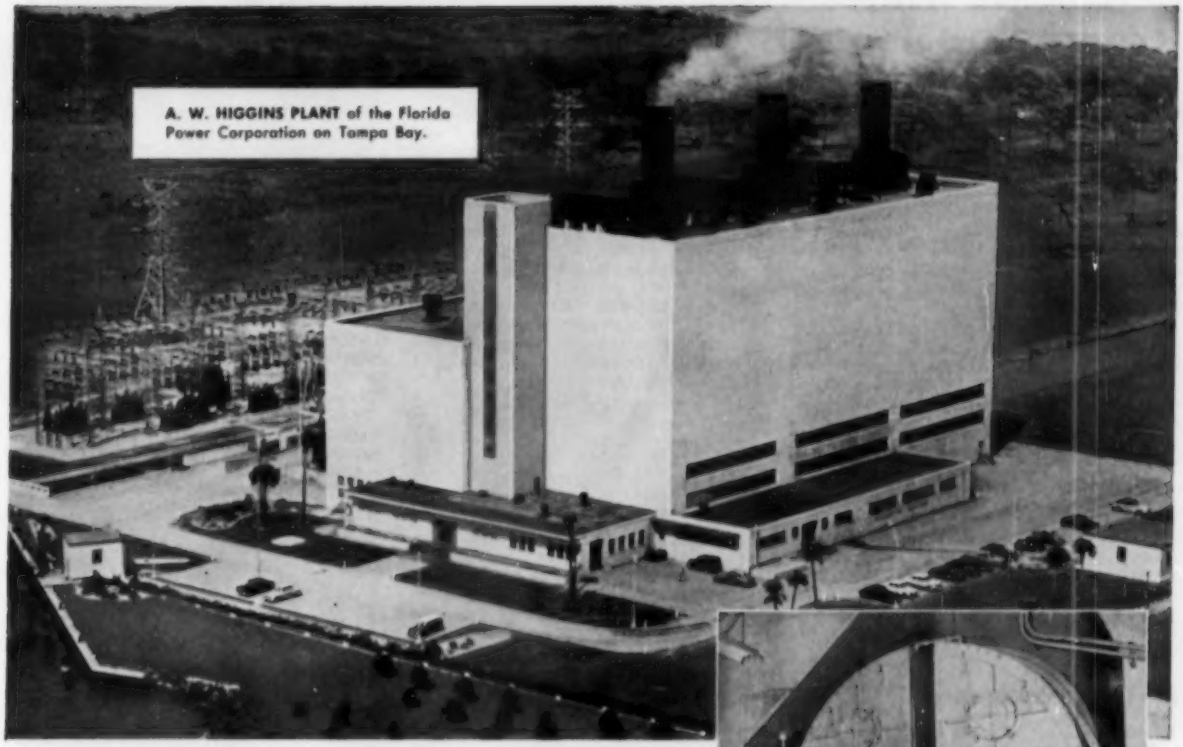
Taking Stock

Cecil W. Smith,
Economics Editor

- **Refining eased from all-time peak**
- **Gasoline stocks at highest level**
- **Oil imports at four-month low**

MONTH	CRUDE OIL			GASOLINE		KEROSINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1953:													
March	6,531	7,002	275,665	3,319	162,731	359	18,697	1,489	59,802	1,256	41,600	655	1,112
April	6,446	6,781	280,487	3,282	158,032	369	20,335	1,424	61,349	1,219	39,572	628	1,010
May	6,390	7,002	290,308	3,366	156,415	327	24,307	1,400	73,706	1,197	41,795	703	1,096
June	6,595	7,081	293,715	3,467	146,196	336	27,659	1,462	84,504	1,238	43,801	707	1,050
July	6,603	7,103	284,976	3,583	143,916	321	31,143	1,441	102,256	1,224	47,530	629	950
August	6,583	7,163	285,332	3,592	146,050	321	35,711	1,437	119,542	1,222	50,007	672	946
September	6,557	7,023	289,614	3,521	144,184	330	37,280	1,448	126,709	1,203	50,516	692	1,013
October	6,262	6,872	287,541	3,437	144,495	355	38,161	1,462	135,409	1,184	50,820	639	990
November	6,277	6,987	283,021	3,528	150,747	354	36,271	1,463	133,381	1,223	51,267	648	1,120
December	6,234	6,964	276,676	3,628	159,949	378	29,070	1,441	111,944	1,247	49,370	598	1,121
1954:													
January	6,240	6,947	270,811	3,431	171,704	390	22,013	1,467	81,044	1,271	47,474	617	1,143
February	6,379	7,068	266,918	3,476	179,950	412	20,183	1,545	70,390	1,241	47,119	621	1,144
March	6,507	6,923	271,867	3,375	181,297	353	17,533	1,458	60,270	1,168	44,249	654	1,088
April	6,615	6,811	280,310	3,404	177,006	322	19,656	1,374	61,721	1,140	44,362	574	950
May	6,471	7,038	282,250	3,482	177,606	302	23,892	1,372	73,581	1,148	47,009	708	1,021
June	6,500	6,947	285,155	3,463	165,404	306	28,184	1,399	86,325	1,123	50,216	624	999
July	6,242	6,916	284,894	3,480	158,010	295	31,953	1,416	101,657	1,089	54,365	724	1,038
August	6,168	6,862	281,043	3,492	153,168	302	34,949	1,453	117,579	1,069	56,332	664	966
September	6,151	6,939	274,608	3,511	150,916	301	37,099	1,514	128,061	1,086	56,702	672	999
October	6,135	6,834	269,442	3,457	149,681	310	37,140	1,545	139,128	1,066	56,541	642	1,055
November	6,346	6,975	264,566	3,530	150,604	354	34,547	1,622	133,886	1,120	54,891	636	1,104
December	6,394	7,238	258,385	3,605	155,400	381	27,826	1,668	108,144	1,187	52,105	729	1,301
1955:													
January	6,761	7,379	260,156	3,639	169,562	409	23,266	1,740	86,692	1,235	49,457	739	1,348
February	6,759	7,501	260,316	3,547	181,753	368	18,826	1,812	67,531	1,245	45,072	789	1,365
March	6,840	7,389	266,488	3,466	185,121	356	18,659	1,727	61,965	1,181	44,836	762	1,269
Week Ended:													
4-22-55	6,832	7,099	272,781	3,425	179,741	321	20,429	1,483	65,678	1,144	44,619	628	1,027
4-23-54	6,586	6,812	269,647	3,331	178,033	308	18,518	1,345	58,932	1,194	43,779	680	1,022

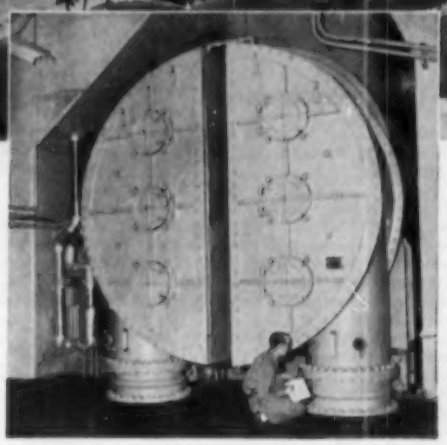
Source: Data for last two months from API; prior monthly data from Bureau of Mines. Data in thousands of barrels.



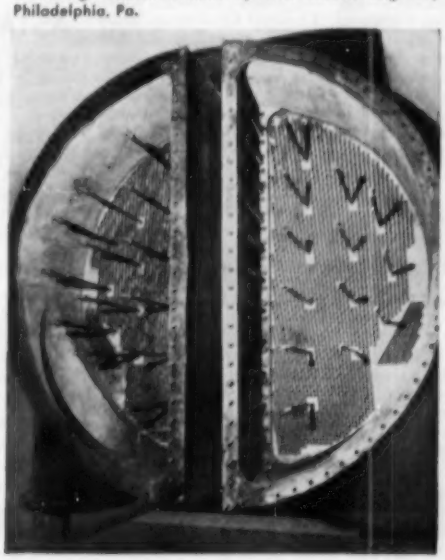
A. W. HIGGINS PLANT of the Florida Power Corporation on Tampa Bay.

REVERE 10% CUPRO-NICKEL SOLVES CORROSION PROBLEM FOR FLORIDA POWER CORPORATION

About six years ago the Florida Power Corporation was experiencing condenser tube failure at its Bayboro plant in St. Petersburg. Revere's Technical Advisory Service was called in, and recommended replacing the failed tubes with 10% Cupro-Nickel, which has a marked resistance to corrosion from brackish water. This recommendation proved successful. As a result, when Florida Power planned to add a new 135,000 KW plant, named after A. W. Higgins, Revere 10% Cupro-Nickel tubes were specified. All three units in the new plant are thus tubed. The tubes are 7/8" OD x 18 BWG, 24' 7" long. A few spares are kept on hand for possible replacement, but with regular cleaning to remove debris (small bits of shell, etc.), the tube life has been exceptional, thus adding to economy of operation and increased service to a fast-growing area. . . . If you have questions regarding condenser tube selection and service, get in touch with the nearest Revere Sales Office. Remember to specify Revere.



Exterior view of one of the condensers in the Higgins plant, and below, one of the three condensers ready for tubing. Condensers made by C. H. Wheeler Mfg. Co., Philadelphia, Pa.



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Reviewing New Books . . .

Calculation Tools

Nomography & Empirical Equations, Dale S. Davis.

Written in a logical, easy-to-read style, this book explains the many engineering applications of the empirical equations and nomography, and shows how to employ these tools to speed up the engineer's daily on-the-job calculations.

It explains the development of empirical equations for two- and three-variable data. Here, new techniques utilizing trigometric and hyperbolic functions, the modified Gompertz equation and other devices for two-variable data are described, along with simple methods for correlating three-variable data.

The volume covers the theory and construction of several industrially important types of alignment and line coordinate charts. With the aid of illustrations, the book shows the step-by-step construction of these charts.

(Reinhold Publishing Corporation, 430 Park Avenue, New York 22, 670 pages, $6.75.)

ASTM Supplements

Supplements to 1952 Book of ASTM Standards, American Society for Testing Materials.

To keep up the triennially-published Book of ASTM Standards, the American Society for Testing Materials issues supplements to each part of the book during intervening years. The 1954 supplements, just issued in seven parts, include 415 items, either issued for the first time in 1954 or revised since their appearance in the 1952 Book of Standards or the 1953 supplements. These latest supplements, together with the 1952 book and the supplements for 1953, include all the society's specifications, test and definitions, except the chemical analysis of metals.

Parts of most interest to the refining industry: Ferrous Metals, 608 pages; Non-Ferrous Meals, 444 pages; Cement, Concrete, Ceramics, Thermal Insulation, Road Materials, Waterproofing and Soils, 416 pages; Paint, Naval Stores, Wood, Cellulose, Wax Polishes, Sandwick and Building Constructions and Fire Tests, 160 pages; Fuels, Petroleum, Aromatic Hydrocarbons, Engine Antifreezes, 308 pages.

(American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., $3.50 a part or $24.50 for the complete set of seven parts.)

Steel Painting Manual

Steel Structure Painting Manual, Volume II, edited by Joseph Bigos.

Released after four years preparation, this second volume, called, "Systems and Specifications," contains specific recommendations on painting a variety of steel structures and surfaces in various exposures.

Complete guides and indexes make it easy for engineers, architects, fabricators, and maintenance supervisors to quickly, easily, and **correctly** specify complete paint jobs for new work or maintenance painting. This volume differs in this respect from Volume I—"Good Painting Practice"—since the latter is an encyclopedia of comprehensive and detailed information on all phases of cleaning and painting steel structures.

In addition to guides and indexes of recommended painting schemes, Volume 2 includes complete specifications for surface preparation, pretreatment, paint application, paints, and paint systems. Now, it is possible to specify the painting of a steel structure in the same method as the steel itself is specified—by reference to a specification number.

(Steel Structures Painting Council, 4400 Fifth Avenue, Pittsburgh 13, Pa., 96 pp., $1.50.)

API Revises Manuals On Tank Cleaning

Two new editions of safety manuals dealing with cleaning tanks have been issued by American Petroleum Institute.

A revised manual on cleaning crude oil and unfinished-products tanks has been published as "Cleaning Petroleum Storage Tanks, Manual 1A." The manual discusses and describes hazards such as fires and explosions, common sources of ignition, the significance of iron sulfides, occurrence and significance of hydrocarbon vapors and aromatics, hydrogen sulfide and tetraethyllead vapor, the likelihood of oxygen deficiency, together with minimum precautionary measures.

The other manual, "API Accident-Prevention Manual No. 13A," takes up procedures for cleaning tank vehicles. Attention is called to measures which should be taken to protect workers against harmful vapor concentrations and to avoid igniting flammable vapors.

Both publications are available at $1 a copy, with discounts provided for bulk orders.

ASTM Standards

ASTM Standards on Petroleum Products and Lubricants, by American Society for Testing Materials.

This special compilation of specifications, indexes, and definitions covering petroleum products and lubricants provides in compact readily usable form the ASTM standards in this field.

Published annually since 1927, the 1955 edition gives in their latest approved form over 100 test methods, numerous specifications, and lists of definitions of terms relating to petroleum. Several appendixes are included covering proposed tests of jet fuels, steam turbine oils and aviation fuels.

Petroleum chemists and other technologists in the industry as well as purchasing agents, sales engineers and others in the automotive, air craft, railway and other industrial fields will find it helpful to have a copy of this publication.

(American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., 980 pp., $6.65.)

Compilation of Data

Some Properties of the Lighter Hydrocarbons, Hydrogen Sulfide and Carbon Dioxide, by B. H. Sage and W. N. Lacey.

This monograph is a compilation of data which resulted from a series of investigations conducted for the American Petroleum Institute at the California Institute of Technology from 1947 through 1953. The book mainly is concerned with the effect of pressure and temperature on molal volumes.

Most of the results of these studies already have been published in other forms. The information has been reviewed, however, and brought into a consistent form to make it more easily accessible in one volume.

Each system is taken up in a separate section, containing descriptive texts, tables, figures and references. The new monograph is intended to complement the authors' earlier valume entitled Thermodynamic Properties of the Lighter Hydrocarbons and Nitrogen.

(American Petroleum Institute, 50 West 50th Street, New York 20, 250 pp., $10, API members $6.)

Chemical Producers Increase in West

An increase of some 43 percent in the number of western chemical producers in the past six years is indicated by the "Directory of Western Chemical Producers," published by Stanford Research Institute. Listed are specific chemical products and plant locations of chemical manufacturers in the western states.

An increase of 98 percent in the number of organic chemicals manufactured in the West is shown since 1948. More than 475 chemical products manufactured by some 350 companies in about 450 western plants are listed.

The directory includes only "prime" chemical producers and "prime" chemical products. It does not include mixtures and formations or firms primarily engaged in such operations. Although several important related products such as synthetic resins, mineral raw materials and modified fats and oils are shown only products manufactured in commercial volumes are listed.

All chemical producers, regardless of size, are covered by the directory.

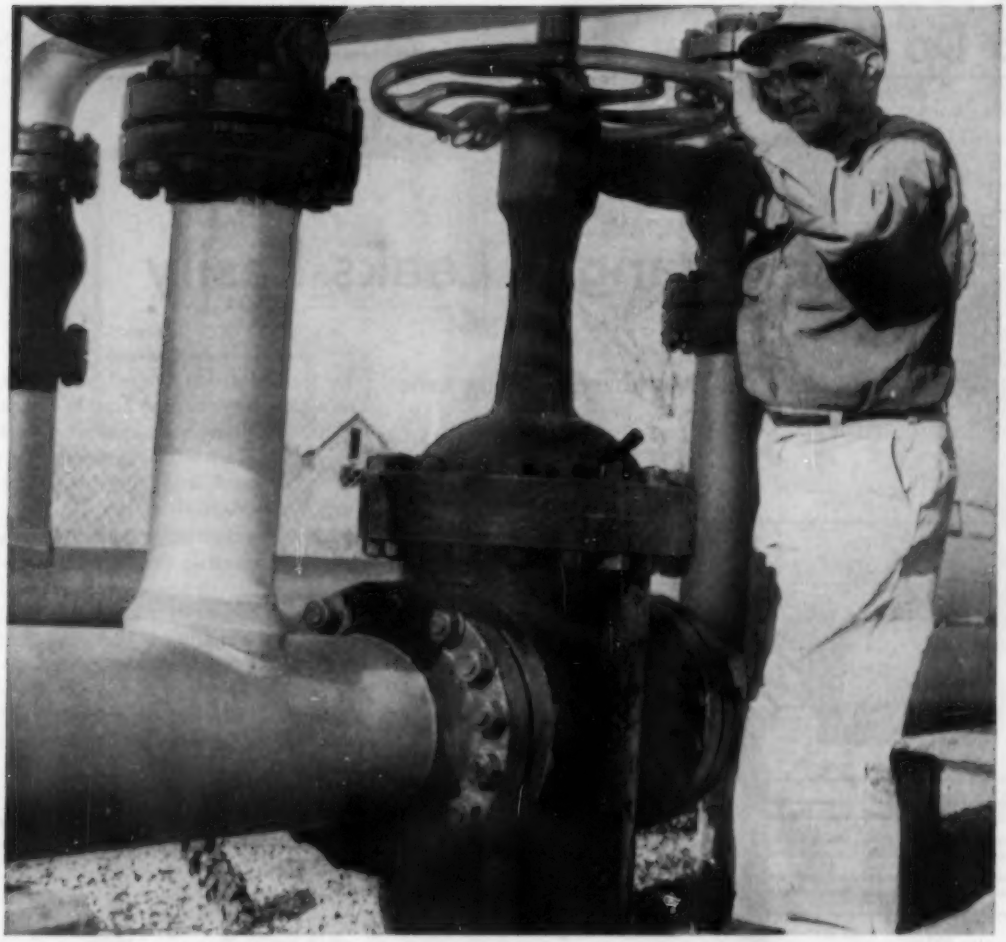
Reference on Steam

Steam—Its Generation and Use, 37th Edition, The Babcock & Wilcox Company.

Now in its 37th edition, this general reference book on steam is intended primarily for mechanical engineers and mechanical engineering students in the applied thermodynamics field. Past editions of this book have been accepted as text books in mechanical engineering courses at colleges throughout the country.

Starting with an historical introduction to steam, the book is very complete with both theory and application. Typical chapter headings: Sources of Heat Energy—Coal, Heat Transfer, Steam Temperature Adjustment and Control, Nuclear Power, and Marine Applications.

(The Babcock & Wilcox Company, 161 East 42nd Street, New York 17, $10.)



Easy does it...year after year with this Crane pipe-line valve

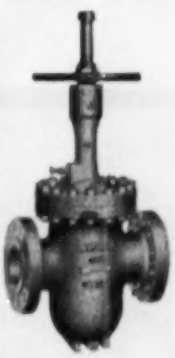
THE CASE HISTORY—More than 3 years ago the Phillips Pipe Line Co. installed this Crane conduit valve in a junction manifold on its 10-inch crude line to Borger, from Yale Station, Oklahoma. How's it doing?

Operated every day or two until a few months ago, this Crane double-seating, grease-packed valve has always responded smoothly and easily to the handwheel—never sticking. Under former frequent usage as now with infrequent operation, it has never leaked at the bonnet joint or packing chamber—remains tight as new at the seats. This Crane valve—because its pressurized stuffing box eliminates leakage—is clean, unstained.

On gas and oil, these Crane valves are making big savings in operating costs. They're the leading value for pipe line service, and thrifty buyers know it. Crane Co., General Offices, Chicago 5, Illinois. Branches and Wholesalers in all industrial areas.

CLASS 600 STEEL PIPE-LINE GATE VALVES

Grease packing in body and bonnet assures thorough internal lubrication for easy operation. Parallel disc design gives tight closure; eliminates seat leakage. Spring plates in contact with disc faces keep foreign matter out of body. When open, conduit ports through disc give straight-line, unrestricted flow. Full-way or Venturi patterns; sizes 2 to 30 in. Literature sent by mail, or ask your Crane Representative.



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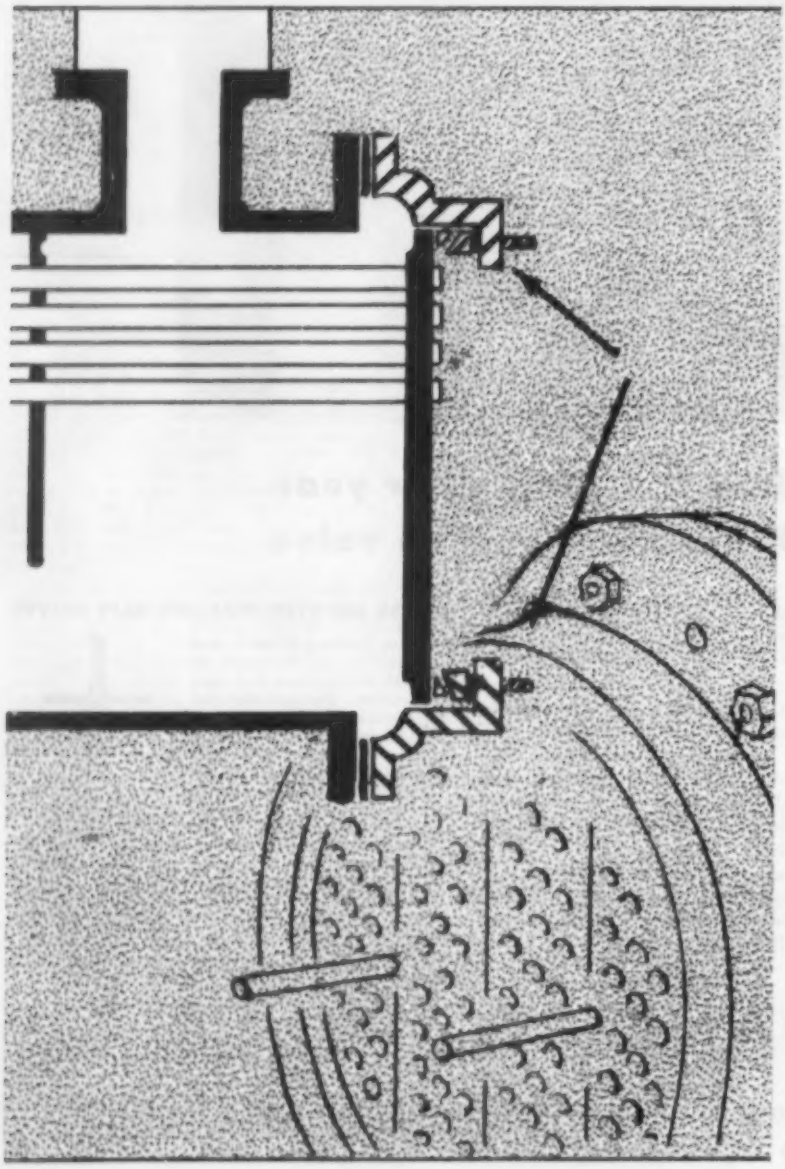
CRANE'S FIRST CENTURY...1855-1955

For more data on advertised products, use Readers' Service Cards, last page.

$10 is paid for each accepted idea. Mail to Editor, Petroleum REFINER, P.O. Box 2608, Houston, Texas

Catch Heat Exchanger Leaks Easily

. . . Formed piece also checks fixed tube sheet, floating tube sheet and exchanger tubes.



A formed piece shaped somewhat like a doughnut can be used to check for heat exchanger leaks, and results in checking the fixed tube sheet, floating tube sheet and the exchanger tubes simultaneously.

Normally the fixed tube sheet is tested by removing the channel cover and applying pressure to the shell side. Leaks occuring at the seal formed by expanding the tube end into the tube sheet will be spotted immediately. However, leaks of individual tubes or leaks in the floating tube sheet cannot be detected by this procedure.

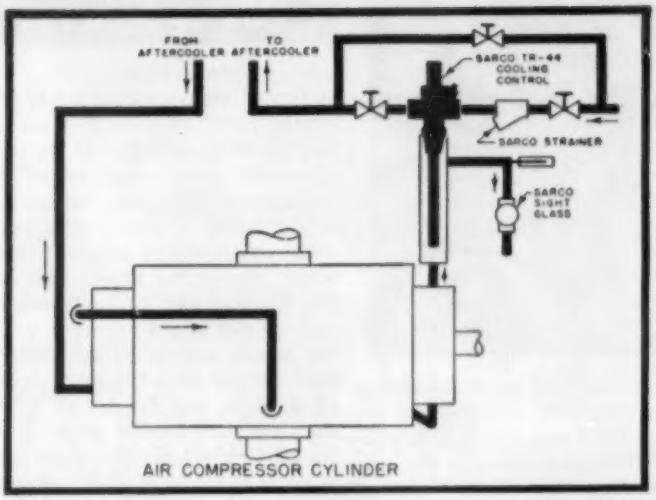
This device forms a seal between the floating tube sheet and the shell flange. Therefore, with the channel cover also removed, pressure can still be applied to the shell side even after the shell cover and floating head are removed, and leaks at both ends of the exchanger can be readily detected.

The drawing shows a sectional view of the testing doughnut and a wedge ring which presses rod packings against the circumference of the floating tube sheet in order to prevent any leakage of the testing medium. The wedge ring is pressed into place by a number of ⅜-inch square head bolts.

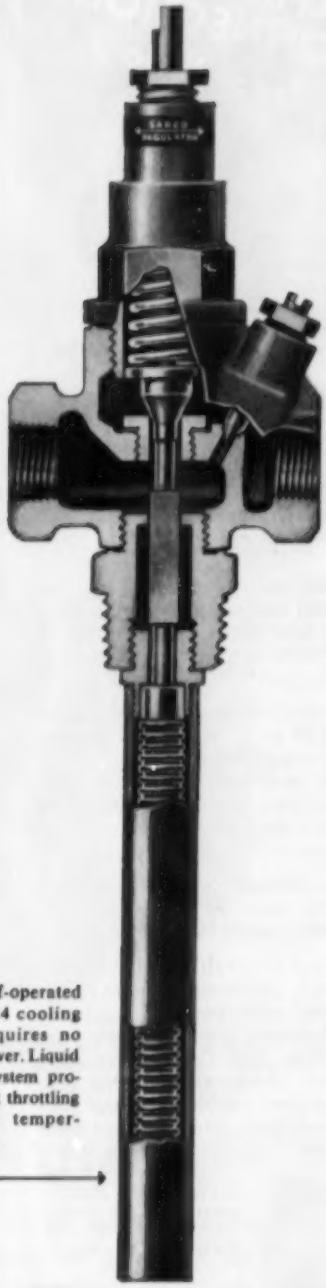
Facilitate Adding Chemicals to Tank

Addition of chemicals to an underground water-treating tank has been greatly facilitated by the welding of a sleeve of 6-inch pipe to the top of the tank. This sleeve extends from 8 to 10 inches above the surface of the ground.

Prior to the installing this sleeve, it was necessary to unscrew some 20 bolts in a manhole cover. The addition of the sleeve has made it possible



Sarco Cooling Control guards against dangerous over and under cooling.



Compressors

work better, last longer, cost less to run

with SARCO

COOLING CONTROLS

YOU have to keep your eye on a lot of things to get top efficiency from compressed air systems – and one of the most important is *cooling.*

For example, overcooling – usually a result of manual control – causes condensation on cylinder walls which destroys lubricant and increases wear. In addition, it wastes water.

If you're undercooling, you're cutting down on compressor capacity – and you're taking chances of damaging cylinders, pistons, valves and seats.

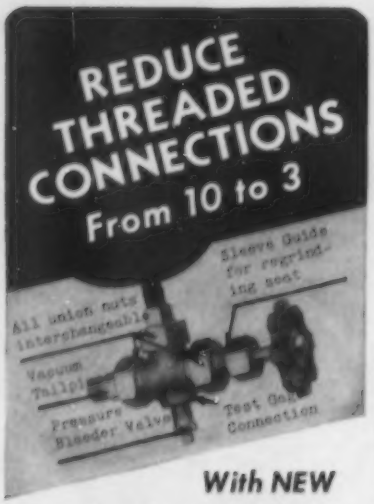
It's a lot easier – and also safer and more economical – to let dependable Sarco self-operated temperature controls take over. They insure optimum cooling effect with minimum water consumption regardless of load variation, changes in pressure and temperature of water supply. *You get protection for compressors with maximum efficiency at minimum cost.*

Send for Bulletin No. 520-A "Is Your Air Compressor Capacity Effective?" Sarco Company, Inc., Empire State Building, New York 1, N. Y. Representatives in principal cities.

Simple, self-operated Sarco TR-44 cooling control requires no auxiliary power. Liquid expansion system provides perfect throttling throughout temperature range.

SARCO

COOLING CONTROLS • DRAIN TRAPS • STRAINERS
THERMOSTATS • PRESSURE SWITCHES



With NEW

JERGUSON VALVES

For Instrument Piping and General Use

YOU can make tremendous time and cost savings with this complete new line of Jerguson Valves for Instrument Piping and General Use.

Threaded connections are reduced from 10 to 3, for these valves combine unions, nipples, reducers, elbows, tees, valve, and drain valve in one space saving unit. One valve replaces the multiple set-up of valves and connections formerly used.

Nine different styles . . . with or without union outlet, as well as offset and jacketed valves.

Features available include safety shut-off; double-seating stem for repacking under pressure; regular or quick-closing stem and lever; regrindable and renewable seats; pressure bleeder valve and test gage connection; outside screw and yoke when desired; throttling stem when desired.

Write for full details today. Ask for Data Unit on General Use Valves.

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Gages and Valves for the Observation of Liquids and Levels

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Offices in Major Cities
Jerguson Trees Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

to add the chemicals simple by lifting a metal cover fitted over the end of the pipe. This metal cover is not threaded, but fits securely in the end of the sleeve.

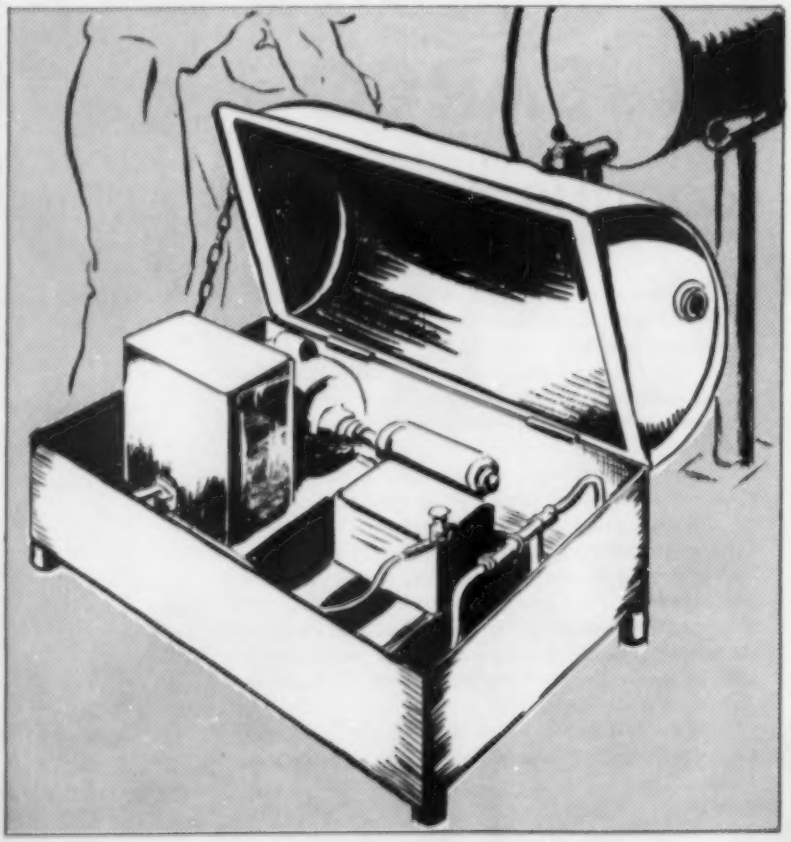
Use Scraps to Make Injector Housing

Service life of chemical injectors can be extended appreciably by housing them in all-weather structures. Here is a small field installation that encloses all the essential operating equipment for injecting a corrosive inhibitor into flow lines.

Top of the structure is half of a regular metal oil drum that has been flanged along the edges of the cut as shown. Base of the weatherproof housing is a sheet metal box that serves as a foundation for the chemical supply sump, the pump and an electric motor which powers the pump. The metal box is placed on four short sections of pipe driven into the ground so that the box is approximately level. The semi-circular lid is hinged to one side of the box, and fitted with a chain that supports the lid when opened slightly beyond the 90-degree angle. A drum of inhibitor is located nearby so that filling is simple. (**See sketch below.**)

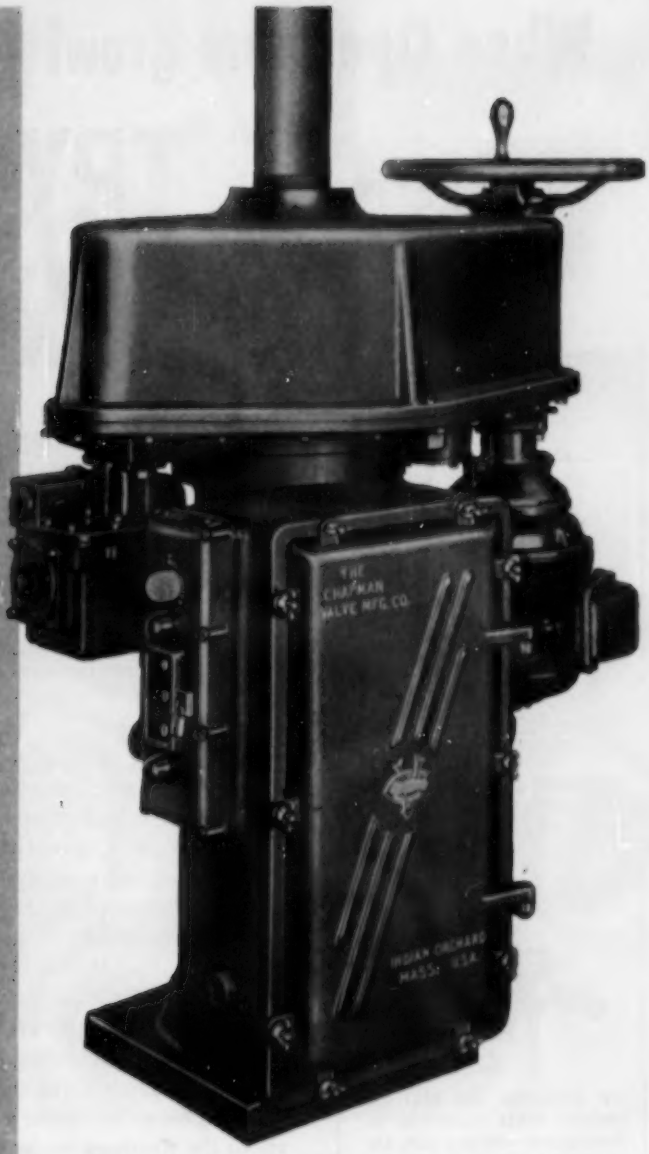
Neat Tool Rack in Engine Room

This engine room operator has solved the problem of easy access to tools by building a wall rack immediately adjacent to the engine. Notice in the picture that all necessary small hand tools, U-tube pressure tester,



Fewer Parts Mean Greater Dependability

Floorstand Motor Unit . . . control panel, motor, limit switch and push button station.



Simple, durable mechanism of Chapman's Motor Unit. Handwheel remains stationary during motor operation.

IN CHAPMAN MOTOR UNITS

Chapman's simple and rugged Motor Unit gives accurate, trouble-free control of large valves and sluice gates. It has approximately *half as many parts* as any other unit. Its simplified design, low speed motors and low-ratio, stubtooth gears combine to give positive operation without drift, in *any* position and under all conditions.

Installation is fast and simple. The floorstand unit comes completely wired, ready to connect to leads. Limit switch has micrometer adjustment for exact pre-setting for seating tightness. Motor Units operate smoothly under the most adverse conditions. All units are weather-proof and steam-tight. Write today for *new* Catalog 51.

The Chapman Valve Manufacturing Co.

INDIAN ORCHARD, MASSACHUSETTS

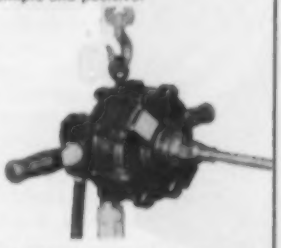
For more data on advertised products, use Readers' Service Cards, last page.

When Operators growl

...TRY LAGONDA

The famous Lagonda 1100 Series refinery cleaner, with the Type UO head. This combination is tough on coke.

AUTOMATIC SIGHT FEED LUBRICATOR controlled entirely by pressure. Simple and positive.



FOR CONDENSER AND HEAT EXCHANGER TUBES. Direct-drive air driven cleaner with long shaft, the motor supported outside the tube by overhead pipe. Motor has trigger control. Also available with electric motor.

CATALYST CLEANER. Removes spent catalyst from tubes, without permitting its escape.

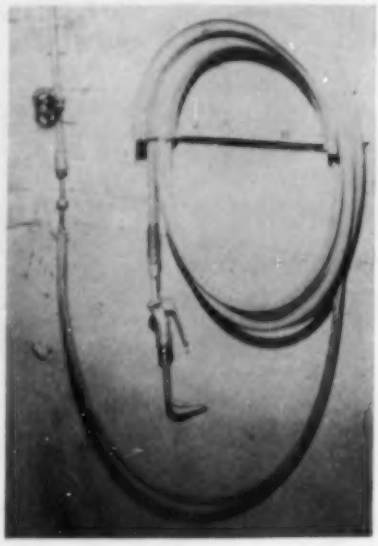
Tube cleaning is a trying chore. You can't blame operators for getting sore at tools that make an uphill job of it, particularly if breakage occurs too often. Nor can you blame operators for trying, when a variety of tools are available, to get the Lagonda cleaner for their personal use. Sometimes an operator will "bunk" his Lagonda cleaner over the lunch-hour, making sure he'll get it again to finish the job. Just about the strongest recommendation a tool could have. To keep operators happy, and get stills back on stream quick, try Lagonda. Check with your nearby Lagonda man before your next cleanout. He can save you valuable time. Or write Elliott Company, Lagonda Division, Springfield, Ohio to put you in touch.

ELLIOTT Company

Y4-4

How to Do It...

chains, lubricating gun, and rings are all at his finger tips and clearly displayed.



Support Air Hose With Half a Tire Rim

A half an automobile wheel may be used to make a hangar for an air hose. Take a welding torch and cut out the inside flush with the rim and then cut the rim into two equal parts. Weld a cross piece across the ends and drill holes for bolts. Drill holes in the wall and use expansion bolts to fasten the hangar at a convenient height. The hose is hung so that the nozzle is hanging down. Other connections to fit tire valves are laid on the top of the cross piece.

CHEMICAL CLEANING HELPED BY PIPE LINE PIG

Dowell saved line replacement cost with fast combination treatment, restoring full capacity in 2½ hours!

Often, the most effective and economical way to clean lines is to use *both* chemical solvents and mechanical methods.

Take a recent case where thick iron oxide scale in a 12-inch water line had so reduced its capacity that costly replacement was necessary—*if cleaning failed*. Dowell engineers decided to use chemical solvents *and* a pipe line pig. Such a combination treatment is often used for speed and economy where scale is extremely hard or thick. In only 2½ hours, Dowell engineers removed the scale and restored the 398-foot line to full capacity.

Chemical cleaning by Dowell often saves you considerable downtime and money, because solvents are introduced through regular connections—dismantling and digging up of buried lines is unnecessary. Moreover, solvents are designed to clean the *entire line*—bends, elbows, valves, and any other hard-to-reach places.

Let Dowell chemical cleaning help restore and maintain the efficiency of lines and equipment in your plant. Call the nearest Dowell office, or write Dowell Incorporated, Tulsa 1, Oklahoma, Dept. E-31.

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

THE "FLEX" IN FLEXITALLIC

Here at Flexitallic Gasket Company we originated the "flex" that is the basic feature of Flexitallic spiral-wound gasket construction. Flexitallic Gaskets are exclusively spiral-wound, the uniquely resilient construction pioneered by the company in 1912. For 43 years our engineers have designed and built only one product — Flexitallic spiral-wound gaskets . . . working with leaders in American industry to make full use of the tremendous sealing power of Flexitallic Gaskets in aviation, atomic research, process industries, power plants, ships of the Navy and merchant marine.

Each Flexitallic Gasket is designed and engineered to meet specific conditions of thermal and physical shock, corrosion, vibration, weaving and unpredictable joint stresses. Spirally-wound V-crimped plies of required metal with alternating plies of proper filler result in a resilient gasket having characteristics of a calibrated spring.

Flexitallic Gaskets are at highest efficiency when bolted up cold at a predetermined load. For all pressure/temperature ranges from vacuum to 10,000 lbs., from extreme sub-zero to 2000°F. For all standard joint assemblies. In four thicknesses for special requirements: .125", .175", .250", .285". In diameters to 84" O.D.

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Flexitallic®
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

TEFLON FOR PROCESS APPLICATIONS

The ideal seal for many process applications is a Flexitallic Gasket with Teflon trapped between edges of stainless steel. Ask for folder, "Teflon in Flexitallic Gaskets."

*Not all spiral-wound gaskets are Flexitallic. Look for *Flexitallic Blue* —it's our exclusive blue-dyed Canadian asbestos filler.

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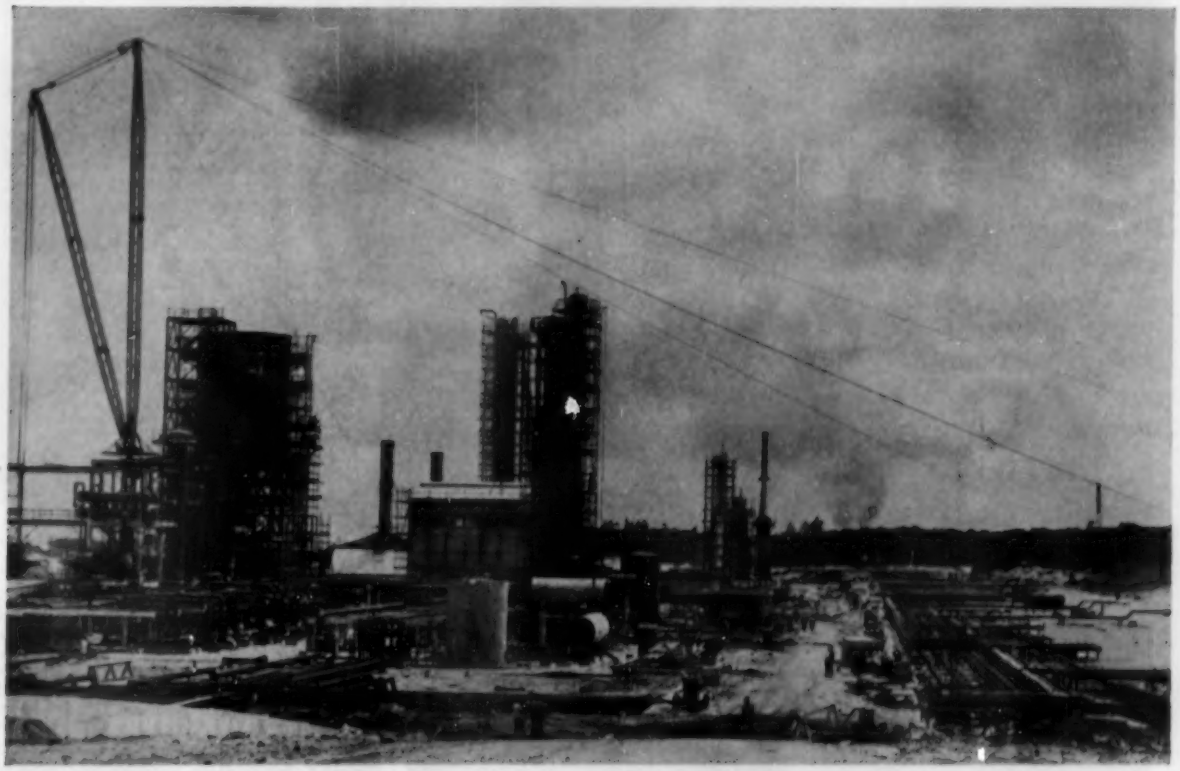

Cat cracker, crude unit, decarbonization unit and main pipeline at Kurnell.

Caltex Nears Completion On Refinery in Australia

. . . New 22,000-barrel-a-day plant to be Australia's third this year.

AUSTRALIA'S NEWEST refinery is nearing completion on the shores of Botany Bay, south of Sydney. Being built by an affiliate of California Texas Company, Ltd., for a daily crude capacity of 22,000 barrels, the $47-million Kurnell refinery is expected to make a major contribution to the Australian economy, long dependent upon imports for petroleum products.

This will be the third new Australian refinery completed this year. Companies affiliated with The British Petroleum Company, Ltd., have a new 60,000-barrel-a-day plant in operation at Kwinana in western Australia, and Standard-Vacuum Refining Company has completed its new 25,000-barrel-a-day plant at Melbourne.

When finished this summer, the Kurnell refinery will be equipped with a two-stage distillation unit, propane decarbonization facilities, a fluid catalytic cracker and a polymerization unit, together with the necessary steam and electric generating plants.

Several units for the refinery, to be operated by Australian Oil Refining, Ltd., a Caltex affiliate, were designed by Stone & Webster Engineering Corporation and its London subsidiary, E. B. Badger & Sons, Ltd. The Stone & Webster organization also designed all offsite general facilities and linkup lines and managed the construction operation at the site.

The principal units of the new refinery include crude oil processing facilities designed for a throughput of 22,000 barrels a day of crude oil for the production of light and heavy

use Laclede-Christy
Castable Refractories

long service-low cost

Laclede-Christy Castables deliver money-saving, trouble-free service because they are especially designed for use by refineries.

Porelite V. L. is used for its high insulating properties and lightness in weight per cubic foot.

Firmcast is used for extra strength and high resistance to abrasion. Both products can be applied by gunniting with minimum amount of waste.

Porelite V. L. and *Firmcast* have passed the test and service requirements at major refineries.

Laclede-Christy also offers the service of experienced personnel who can help you solve special problems. Why not take advantage of this extra service?

LACLEDE-CHRISTY COMPANY

HKP

DIVISION OF H. K. PORTER COMPANY, INC.
2000 Hampton Avenue • St. Louis 10, Missouri
Mission 7-2400

Who's Building . . .

products ranging from gasoline to heavy fuel oil.

The crude topping unit consists of an atmospheric still including a stabilizer and a vacuum still. Gasoline, kerosene and diesel fractions are produced in the atmospheric sections of the unit and a wide-cut gas oil and a short residuum in the vacuum section.

A 6,000-barrel-a-day propane decarbonizing unit is included in the processing scheme to produce catalytic cracker charge stock from the vacuum still residuum and an asphalt product suitable for blending into fuel oil.

The 15,000 barrel-a-day fluid catalytic cracking unit, with the attendant gas recovery unit, processes heavy gas oil from the vacuum unit and decarbonized oil for the production of gasoline, heavy naphtha and light gas oil.

A propylene-rich stream from the gas recovery unit is processed in a 1,700-barrel-a-day catalytic polymerization unit to produce high octane polymer gasoline for blending into motor fuels. Facilities for product and lead blending are also included in the plant processing scheme.

Planned and Projected:

Can-Amera Oil-Sands Development, Ltd., has completed preliminary financing for construction of a plant at Edmonton, Alta., to process oil from the Athabasca tar sands in northeast Alberta. The plant would be part of a $50 million venture, in which Can-Amera is joined with Canadian Petrofina, Ltd., and Calvan Consolidated.

Curry Chemical Company, wholly-owned subsidiary of Phillips Petroleum Company, will begin construction of a 40-ton-a-day liquid mixed fertilizer plant near its dry fertilizer mixing facilities at Scottsbluff, Neb.

The new plant, expected to be in operation sometime this spring, will produce liquid fertilizer containing nitrogen and phosphate, along with potash when desired. It will be primarily a developmental facility.

Equitable Gas Company plans to build a processing plant at Maytown, Ky. The plant, due for completion early next year, has been designed to recover 10 Mmcf. of ethane concentrate from the 50 Mmcf. of gas to be processed daily.

Cities Service Oil Company has received approval for a raid tax write-off on a proposed $3,597,000 refining project at Ponca City, Okla. Certification was made on $2,808,000 at 65 percent and on $789,000 at 45 percent.

Shell Chemical Corporation will begin work on a new hydrogen peroxide plant near Shell Oil Company's refinery at Norco, La. Part of Shell's new program to make synthetic glycerine, the plant is being designed to produce more than 30 million pounds a year.

A second plant, to be built later, will make acrolein, while a third new plant will produce glycerine, using acrolein and hydrogen peroxide as intermediates.

The new plants will use processes devel-

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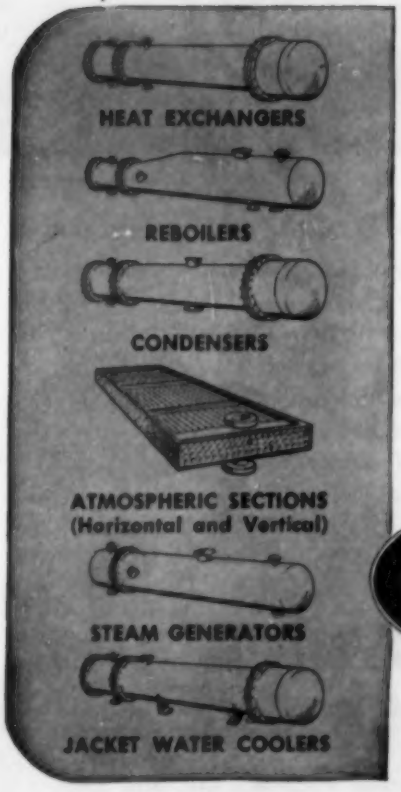
Why EFCO?

Performance is the answer!



With the installation of EFCO heat transfer units in your plant, you will be sure of getting *guaranteed performance* with the extra advantages of low maintenance cost, high operating efficiency, long life and freedom from leaks.

Talk over your heat transfer problems with an EFCO engineer. He will tell you about EFCO installations that have successfully solved problems similar to yours and explain how EFCO equipment will give you the performance you want.

ENGINEERS & FABRICATORS, INC.
P. O. Box 7395 Houston 8, Texas

EFCO

HEAT TRANSFER EQUIPMENT

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NORRISIZED* ... *Inside and Out*

*ELECTRO-GALVANIZED

W. C. NORRIS offers Swaged Nipples and Bull Plugs with the exclusive NORRISIZED protection INSIDE, as well as outside, to meet the ever-increasing demand of producers, pipe line operators and refiners.

At no additional cost, this famous corrosion and rust-proof protective armor marks another service to the industry by W. C. NORRIS, the world's largest manufacturer of swaged nipples and bull plugs.

Finest quality seamless steel PLUS precision threading and close dimensional tolerances make W. C. NORRIS your BEST source of supply for Quality Fittings.

Your SUPPLY STORE IS OUR DISTRIBUTOR

W.C. NORRIS MANUFACTURER, INC.

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Since QUALITY PRODUCTS 1882

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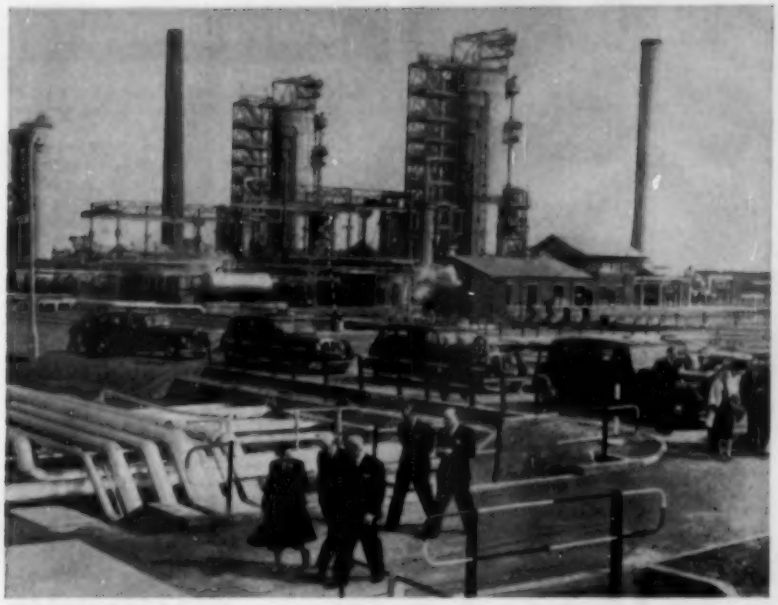


The Queen Visits BP's Kent Refinery—

Queen Elizabeth and the Duke of Edinburg recently visited the Kent refinery on the Isle of Grain. The refinery, owned and operated by The British Petroleum Company, has a daily thruput of 80,000 barrels. The royal party are shown arriving to inspect the recently-completed 6000-barrel-a-day Platformer. In the background are the atmospheric distillation unit and the two vacuum units.

oped by Shell Development Company, which also originated the earlier process of making glycerine from petroleum. This is the process in use at the Shell plant in Deer Park, near Houston, where a fourth of the U. S. consumption of glycerine is produced.

Texas Refiner Receives ODM Write-Off Approval

The Office of Defense Mobilization has issued a rapid tax write-off certificate to Southwestern Oil & Refining Company for construction of a 7125-barrel-a-day catalytic reforming unit and auxiliary facilities at its Corpus Christi, Texas, refinery. The company will be allowed 65 percent on $1,650,000 for basic refining facilities, plus 45 percent on $495,000 for auxiliary facilities.

The largest single amortization certificate went to Miami Oil & Refining Company for construction of a 15,000-barrel-a-day refinery at West Palm Beach, Fla. The company was authorized to write off $6,442,000 at 65 percent and $5,043,000 at 40 percent.

Cities Service Oil Company received a certificate of necessity for construction of a 6000-barrel-a-day catalytic-reforming unit and auxiliary facilities at its Ponca City, Okla., refinery. Fast tax write-off will be allowed on 65 percent of $2,808,000 for basic facilities and 45 percent on $789,000 for auxiliaries.

Woodward & Company, a Dallas firm, was granted a fast write-off on construction of a 690-barrel-a-day natural gasoline plant in McClain County, Okla. The certificate applies to 65 percent of $374,240.

Standard Oil Company (Ohio) was approved for additions and revisions to a catalytic polymerization unit at its Lima, Ohio, refinery, with a 65 percent write-off on $309,000 and 40 percent on $25,000.

Excelsior Refineries, Ltd., together with B. D. Bohna and Company, Ltd., a Vancouver, B. C., firm, and E. V. Lane Corporation, a Palo Alto, Calif., company, have awarded a joint contract for construction of a 2000-barrel-a-day refinery at Dawson Creek, B. C. The new refinery, with foundations built last fall, is expected to be on steam by the end of the year.

Foster Grant Company, Inc., will expand production at its Baton Rouge, La., styrene monomer plant to more than double its present capacity. The plant, completed about a year ago to produce 24 million pounds a year, will be expanded for an annual output of 50 million pounds.

Who's Building. . .

Canadian Chemical Company, Ltd., has approved plans to install additional equipment at its Edmonton, Alta., plant, for the production of methyl isobutyl ketone, methyl isobutyl carbinol, methyl ethyl ketone, 3-methoxybutanol and 1,3 butylene glycol. This will be the first time these chemicals have been produced in Canada.

Acetaldehyde, formaldehyde, acetone and methanol, already produced at the company's Edmonton plant, will be used as raw products. The new equipment is expected to go into operation by midsummer.

Tide Water Associated Oil Company has reached the engineering stage in its plans to build the West Coast's largest coking unit at its refinery near San Francisco. The company plans a 42,000-barrel-a-day fluid-coking unit.

Standard Oil Company (Indiana) will add 6000 barrels daily capacity to its Mandan, N. D., refinery with the construction of a new ultraformer. Construction will begin this summer, with initial operations scheduled for the late spring of 1956.

Other additions to the 30,000-barrel-a-day plant will include an increased steam generating capacity to service the new unit, plus an increase in utility facilities. Standard completed the refinery at Mandan last October.

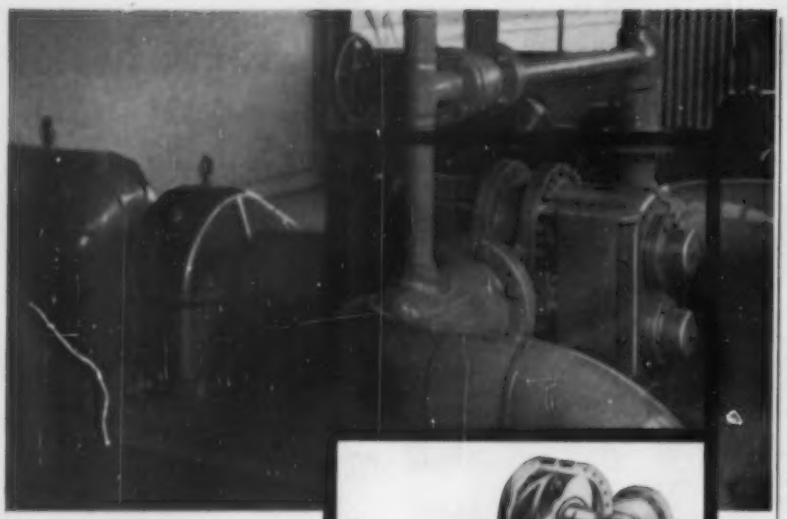
The company has awarded C. F. Braun & Company the contract to build a new 55,000-barrel-a-day crude still at its Whiting, Ind., refinery. Completion is scheduled for early 1956.

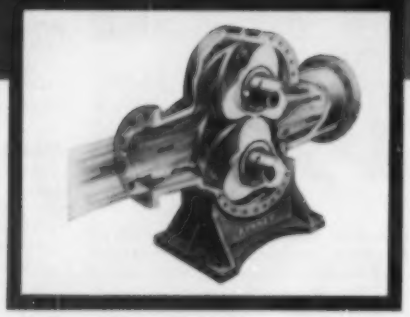
Shell Oil Company of Canada, Ltd., has scheduled a $14-million expansion for its Montreal East refinery. Due to be completed about the middle of 1956, the extensions will increase the plant's daily capacity from 44,000 barrels to 55,000.

The program falls into three phases. Now underway is a $4-million phase which includes installing a new vacuum-flash unit

'Doughnut' Laboratory Takes Shape—

One of the most unusual laboratories in the world is nearing completion at Ponca City, Okla., where Continental Oil Company is converting a 80,000-barrel storage tank into a three-story building. The doughnut-like building will have offices and laboratories around the outside, leaving an air shaft down the middle. Faced with aluminum siding and to be insulated and air-conditioned, the building will house 60 scientists and technicians. Costing $500,000, the laboratory is expected to be finished this summer.





Pump Maintenance is BUILT OUT of this picture

You are looking at a Kinney Model HQA Heliquad Rotary Pump in refinery service — the best in positive displacement pumping for continuous, non-pulsating delivery of all viscosities from aromatics to heaviest crudes. Where maintenance-free performance is essential (fuel oil transfer, for example) you can't beat a Kinney HQA Pump. Because its bearings and timing gears are external to the pumping chamber and there's no metal to metal contact of the working parts, this pump is practically indestructible.

Kinney has the right rotary pump for your job. Heliquad Pumps are available in iron, steel, or bronze constructions, with displacements from 20 to 2700 GPM — for pressures to 300 psig, (temperatures to 650°F and above depending upon size of pump and type of liquid). Send today for complete details. Kinney Manufacturing Division, Boston 30, Mass. District offices in Boston, New York, Philadelphia, Cleveland, Chicago, and Los Angeles.

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Who's Building . . .

and boosting the plant's catalytic-cracking capacity from 16,500 barrels a day to 19,500 barrels.

In its capacity move, the company will replace the smaller of two existing stills, a 15,000-barrel-a-day unit, with a unit built for 26,000 barrels, giving the plant its additional 11,000-barrel capacity. A contract for the second phase of work was let to Arthur G. McKee Company, which also is handling the first phase.

Included in the third phase of the program are plans to build a 6600-barrel-a-day Platformer and a hydrodesulphurizer. The latter, to be used on catalytic-cracking feedstock, will be the first in the world to be so employed. The Platformer is expected to cost $2-million.

Major additions to utility and off-site facilities, estimated to cost more than $4 million, will be required to support the over-all program.

Other expansions of Shell's Canadian facilities include the addition of a $1.5-million Platformer at the Vancouver refinery. The improvement will follow a $10-million expansion completed at the refinery last year.

Kimball Gas Products Company, an Odessa, Texas, firm, is due to start building a $1-million absorption-type gasoline plant in southern Kimball County, Nebraska. The plant will be built for a daily capacity of 7.5 Mmcf of wet gas, with liquid production expected to total 10,000 gallons of gasoline, 12,000 of butane and 15,000 of propane.

Phillips Chemical Company will produce polyethylene at a new plant to be started immediately at the company's Houston chemical works. Another polyethylene plant will be built at the Phillips Petroleum Company refinery near Sweeney, Texas.

No cost figures have been released for either project. Nor has the company disclosed the initial capacity of its projected Houston plant. The unit in Sweeney, however, will be geared to produce 145 million pounds a year.

The first unit of the Houston plant will be rushed to completion, with additional production facilities to be completed at intervals of several months. Another phase of Phillips expansion will be a new chemical research laboratory to be built at the company's Bartlesville, Okla., research center.

The Texas Company will begin construction early this summer on a catalytic reforming unit at its Casper, Wyo., refinery. The 4800-barrel-a-day unit is scheduled for completion early in 1956. Texaco's refinery has a rated crude capacity of 17,000 barrels a day.

Shell Oil Company will add a new 16,000-barrel-a-day catalytic reforming unit at its Houston refinery. A new hydrodesulfurization unit of the same capacity will be built for operation in conjunction with the reformer.

The units, to be built by Procon, Inc., will be used to manufacture high-octane gasolines from naphthas. Construction will begin immediately, with completion scheduled for early 1956.

The new units will be located adjacent to the plant's present reformer and aro-

Sheffield bolts beat big league baseball deadline

Structurals of Kansas City's Major League Stadium were bolted together in record time.

When Kansas City acquired the American League franchise from Philadelphia last November, the old city ballpark had to be rebuilt to major league standards in time for the new Kansas City Athletics opening game April 12. It was done, thanks in no small part to the speed and ease of installation of Sheffield High-Strength Structural Bolts.

Two men can fit and tighten approximately 400 bolts in a working day, compared with 300 to 350 rivets for average *four-man* riveting crew.

The cost of an installed high-strength bolt is estimated by many erectors at 50¢ as against 80¢ for a rivet. Sheffield High-Strength Bolts, because of their greater clamping and load strength, add to the life of the structure... stay tight even under vibration caused by thousands of feet stomping in unison.

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Write for copy of High-Strength bolt book entitled "Successor to the Rivet."

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High-Strength Structural Bolts

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Who's Building...

matics concentration unit, which have been in operation since early in 1953.

A new boiler will be added later this year, having a capacity of 250,000 pounds an hour at 650 pounds a square inch. The boiler will be needed to care for the additional load imposed by plant expansion.

Shell Oil Company will add a new 16,000-barrel-a-day catalytic reformer at its refinery in Houston and install a new hydrodesulfurization unit of the same capacity.

Gonzalez Chemical Industries, Inc., will build a $12,250,000 anhydrous ammonia plant in Puerto Rico. The plant, designed to produce 42,000 tons a year, will be located on Guanica Bay, on the island's south coast.

Part of the plant's output will be sold in Puerto Rico, and the balance will be converted to aqua ammonia, sulphate of ammonia and other compounds.

The Lummus Company is designing the plant and will handle construction. Serving as consulting engineers on the project is Cox & Weinrich, a Washington, D. C., firm.

Mid-Continent Petroleum Corporation has awarded a contract for construction of a 7000-barrel-a-day delayed coking unit to The M. W. Kellogg Company. The coker, to be completed late this year, will process heavy residuum from the company's 65,000-barrel-a-day distillation units at Tulsa. The project is expected to cost $2.5 million.

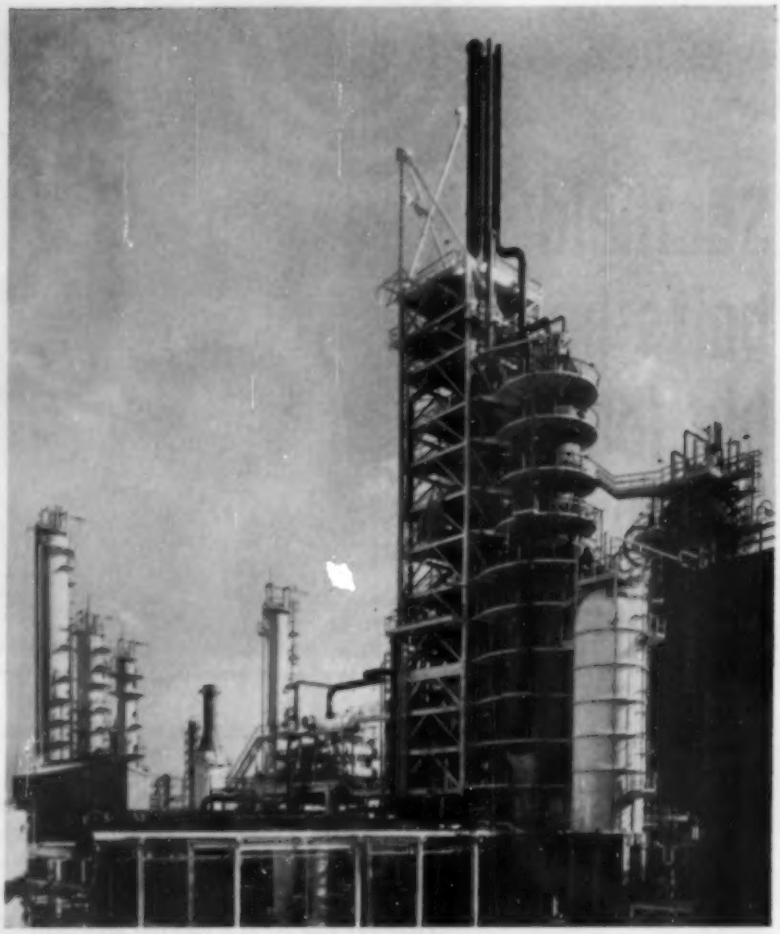
Farmington Funding Corporation has acquired an 85-percent interest in Wisconsin Oil Refining Company, and plans an immediate expansion of its 5000-barrel-a-day refinery at Sheboygan, Wis. Koch Engineering Company will build a 2500-barrel-a-day vacuum still.

Farmington, a Colorado Springs investment firm, also has purchased 30-percent interest in Corpus Christi Refining Company. The refining company operates an 8000-barrel-a-day plant in Corpus Christi, Texas.

Edgington Oil Refiners, Inc., will build a $3-million asphalt refinery at Manila in the Philippines. The plant will process U. S. crudes shipped by its Long Beach, Calif., owners.

The only refinery operating in the Philippines, the 13,000-barrel-a-day Caltex (Philippines), Inc., plant at Manila, manufacturers no asphalt.

Societa per Azioni Raffineria Padana Olii Minerali has an expansion program underway at its refinery in San Martino di Trecate, Italy. The company, in which Caltex is associated with the Italian firm of Fiat, is building a 2800-barrel-a-day catalytic cracker, a vacuum unit rated for 5150 barrels a day, and a polymerization plant with a daily capacity of 315 barrels.



World's Largest Hydroformer on Steam—

Esso Standard Oil Company's new fluid hydroformer, now in operation at the company's refinery in Baton Rouge, La., produces up to 25,000 barrels a day of high-octane gasoline. The largest such unit ever built, the $1,280,000 hydroformer was built by C. F. Braun & Company. Specifications for the unit were prepared by Esso Research & Development Company, the organization which developed the fluid-hydroforming process.

Societe Cherifienne des Petroles will build a new thermofor catalytic cracking unit at its refinery near Petitjean, Morocco. The new unit is expected to provide an annual capacity for 160,000 tons of crude from the Oued Beth oil field.

General Petroleum Corporation has earmarked $5.6 million for further expansion of its new 35,000-barrel-a-day refinery at Ferndale, Wash. Initial construction on the $40-million plant was completed March 1, 1955.

Increased facilities planned for Ferndale include additional boiler capacity, additional tankage, additional product-treating units and additional gasoline-reforming facilities. Construction is expected to be spread over the next two years.

Southwestern Oil & Refining Company has been granted rapid tax amortization on $2,195,000 to be used in building new refining facilities at Corpus Christi, Texas. Office of Defense Mobilization approved certification of $1,650,000 at 65 percent, and $495,000 at 45 percent.

The Texas Company plans to build a 20,000-barrel-a-day refinery in Cuba. Scheduled for completion in January 1957, the plant will process Venezuelan and Columbian crudes.

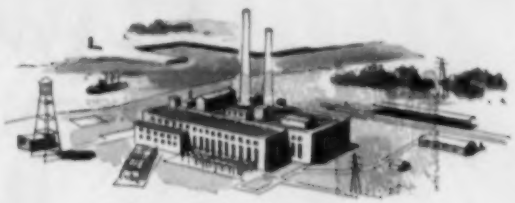
Texaco also expects to increase its principal research facilities at Beacon, N. Y., and expand facilities at its Port Arthur, Texas, laboratories.

Odessa Natural Gasoline Company has let a contract to Bowden Construction Company, another Odessa, Texas, firm for a $1.5-million expansion of its gasoline plant in Ector County, Texas. Construction was to begin immediately.

Gas-processing capacity of the plant will be increased from its present 27 Mmcf a day to 40 Mmcf. New and enlarged facilities will more than double production at the plant, increasing output from 50,000 gallons a day to 110,000 gallons.

American Oil Company has given The M. W. Kellogg Company a contract to build a 35,000-barrel-a-day crude unit and a 30,000-barrel-a-day fluid catalytic

PETRO-CHEMICAL PLANT in Texas to produce ethylene from natural gas by the owner's process.



GENERATING PLANT, one of three of 66,000 KW each, installed for electric utility company in Southwest.

ORGANIC CHEMICAL PLANT to produce insecticides—DDT and BHC—located in the State of Alabama.

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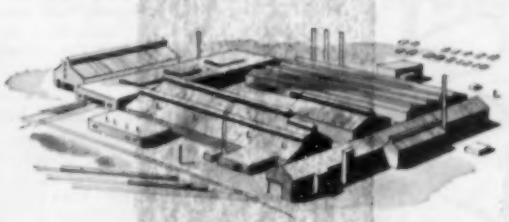
PAPER MILL in the South's pine belt, increasing its capacity by nearly 500 tons of newsprint daily.

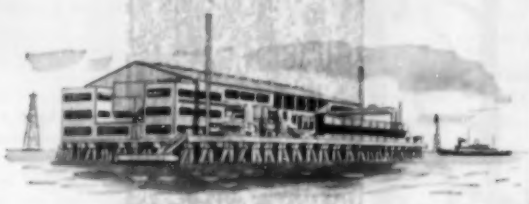


STEEL MILL facilities expanded through contract with Brown & Root in excess of $70,000,000.

More than forty years of diversified experience in engineering and heavy construction in projects ranging from $50,000 to $125,000,000 in size... has put a razor-sharp edge on the Brown & Root estimating pencil.

This same sharp pencil can do the figuring for you with the same assurance known to a long list of satisfied Brown & Root clients... a list that reads like the Who's Who in Industry.

Behind each of our successful completions are arrayed the vital Brown & Root services developed by this long diversified experience... plant location data, economic surveys, design, engineering, home office supervision, cost accounting, procuring and expediting... all the cogs necessary to produce an economical, efficient facility for you. If your plans call for new construction or expansion, call Brown & Root. Plant planning experts will be put at your disposal. No obligation, of course.



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. . . PLUS — improved process efficiency, increased throughput capacity, the elimination of costly liquid loss . . . may be obtained when Yorkmesh Demisters are on the job providing clean separation between liquid and vapor.
When installed in new or existing equipment, these low cost knitted wire mesh pads assure separation efficiencies above 99.9% and make possible overhead products of unusual purity, such as:

- **Gas oil for catalytic feed stock with less than 0.2 ppm. heavy metal poisons.**
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- **Complete removal of sulfuric acid mist from dried chlorine.**
- **Separation of liquid hydrocarbons to give natural gas containing less than 0.1 gallons liquid per million cu. ft. of gas.**
- **Colorless distillate from crude fatty acids.**

Without any obligation on your part, we'll be pleased to study your needs and submit specific recommendations. Or, for further facts on Yorkmesh Demisters write for Bulletin 16.

POSITIVE SEPARATION MEANS HIGHER OVERHEAD QUALITY

Liquid droplets entrained in the vapor stream are impinged on the extensive wire mesh surfaces. The fine droplets coalesce and the liquids drain free. The clean vapor passes overhead.

Yorkmesh Demisters provide clean separation between liquid and vapor in:

Vacuum towers • Distillation Equipment • Gas Absorbers • Scrubbers • Evaporators • Knock-Out Drums • Steam Drums

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Who's Building . . .

cracking unit with an integral polymerization unit for its new refinery at Yorktown, Va.

Major contracts still have to be let for a catalytic reformer, a coker, a gas-oil desulphurization unit and the buildings.

Standard Oil Company of Texas will build a 4300-barrel-a-day catalytic reformer and feed-preparation unit at its El Paso, Texas, refinery. A fast tax write-off was approved at an estimated total of $2.7 million.

Calumet Nitrogen Products Company has awarded a contract for construction of an ammonia and ammonia nitrate plant in Hammond, Ind. The contract went to The Fluor Corporation, Ltd., which expects to complete the 300-ton-a-day plant by mid-1956.

Mekog is planning a new nitrogen-fertilizer plant at Velsen-Ymuiden in the Netherlands. The plant will boost the company's annual production of fertilizer from 370,000 tons to 500,000 tons over the next few years. Cost will be around $9 million.

Utah Oil Refining Company is expected to produce premium gasoline in excess of 100 octane at its refinery in Salt Lake City. The company, a Standard Oil Company (Indiana) affiliate, will build a $3-million ultraformer. The unit is due to be completed next year.

Ente Nazionale Idrocarburi has signed a contract with a second U. S. company for help in building its proposed synthetic rubber facilities at Ravenna. Phillips Petroleum Company agreed to handle the engineering and give technical assistance in building the Italian state agency's copolymer facilities. Earlier, Union Carbide & Carbon Company had entered an agreement to act as consultant in designing and constructing the butadiene plant.

Utah Oil Refining Company has set aside $1,750,000 to cover 1955 costs of building its new $3-million ultra-former. The unit, now under construction and scheduled for completion next year, is expected to produce 101-octane premium-grade gasolines and 93-octane regular grades.

Under Construction:

Oriental Refining Company has started rebuilding a thermal cracking unit damaged in a recent explosion at its 3500-barrel-a-day Denver refinery.

The Texas Company will have a new Unifiner-Platformer unit in operation at its West Tulsa refinery this summer. The unit is being built to process 9040 barrels a day of straight-run naphtha, producing a high-octane gasoline with a controlled low sulphur content.

Utilizing by-product hydrogen from the Platformer, the Unifiner removes sulphur from the naphtha feed. With a platinum

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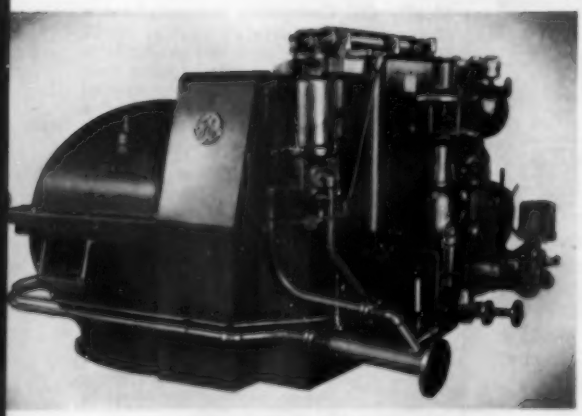
VIBRATION RECORD, inset, is obtained by exciting buckets. Peaks indicate resonant vibration response of buckets. For more reliable operation, G-E engineers confine bucket exciting frequencies to "quiet zones" between the peaks.

How G-E Engineers Locate "Quiet Zones" for Safer High-speed Turbine Operation



TYPE DRV HIGH-SPEED MECHANICAL-DRIVE TURBINE

When driving modern compressors and blowers, G-E high-speed turbines spin at operating speeds of 7000 rpm and up. At such speeds, if resonant vibration were not controlled carefully, bucket fatigue failure might result.

HERE'S HOW General Electric combats the problem: Natural vibration frequencies of the buckets on each new turbine rotor are determined with the special equipment shown above—an oscillator, crystal pick-up, and high-speed level recorder. "Quiet zones" of minimum normal vibration are clearly revealed.

With this information available, the number of nozzles can be varied so that steam striking the buckets will create vibration-exciting frequencies only in these "quiet zones." By thus making sure that steam-impact frequencies don't coincide with critical natural frequencies, the chance of bucket failure is greatly reduced.

VIBRATION TESTING is one of many features that add to the reliability of G-E high-speed turbines. For more information, contact your nearest G-E Apparatus Sales Office or write General Electric Company, Schenectady 5, N. Y. 241-2

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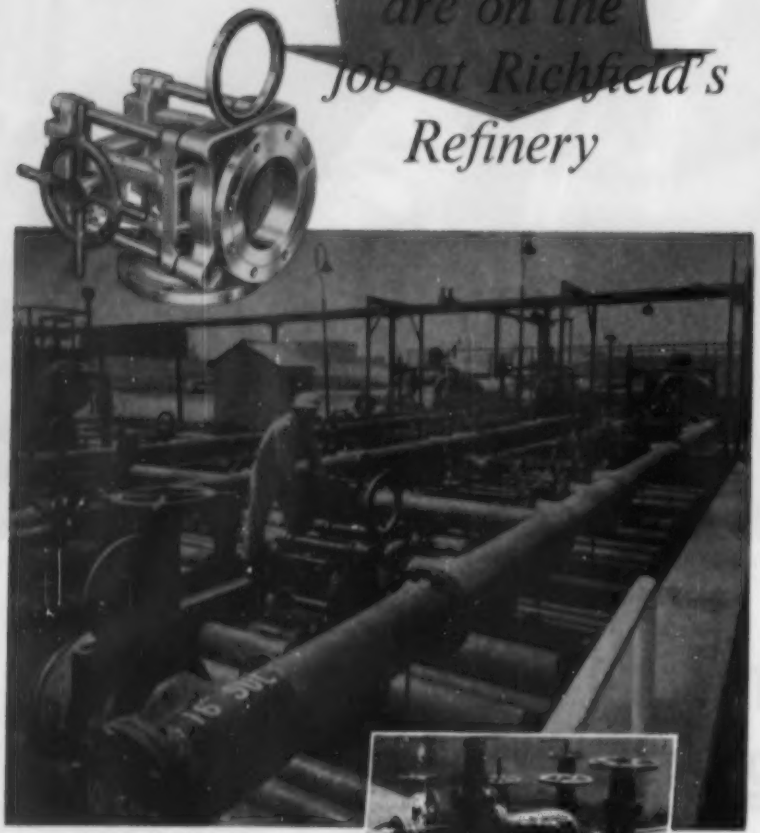
are on the job at Richfield's Refinery



After testing their action in a trial installation, Richfield now uses Hamer Line Blinds extensively at its refinery at Watson as illustrated above.

HAMER *Visible Shut-off* LINE BLIND VALVES

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Thousands of users have proven the easy and immediate operation of Hamer Plug Valves. Will not stick or freeze.

Refinery operations require a valve that will provide a continual leakproof line shutoff. Hamer Blinds with their foolproof sealing action are unsurpassed for providing an absolute line seal that's both positive and permanent. In addition, Hamer Blinds fast, one minute, one man operation literally pay for their cost in downtime saving.

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Who's Building...

catalyst, the Platformer in turn converts the low-octane naphtha into high-octane gasoline.

The unit, being built by Refinery Engineering Company, is one of ten such units under construction or in operation at Texaco plants.

The Standard Oil Company (Ohio) will complete its $17-million petrochemical plant at Lima, Ohio, on or ahead of schedule in November, 1955. The plant, being built for Standard by The M. W. Kellogg Company, will manufacture anhydrous ammonia, urea, nitric acid and nitrogen solutions.

Socony-Vacuum Italiana, S. p. A., is building a new catalytic-cracking unit at its refinery in Naples. Socony-Vacuum Oil Company has bought nearly $11 million in U. S. government guarantees to cover investments in the Italian subsidiary.

The company also is installing a catalytic-polymerization unit, expected to cost $724,000. Both units are due to be completed this summer. Mediterranean Builders, Inc., is in charge of engineering the expansion.

Esso Petroleum Company, Ltd., has started construction on a $28-million expansion of its refinery at Fawley, England.

Additional equipment will permit the company to turn more of its production at the 146,000-barrel-a-day plant into heavy fuel oil. Present output of fuel oil at Fawley is about 35,000 barrels a day.

This year, the company, a subsidiary of Standard Oil Company (New Jersey), expects to import about 3.5 million tons to meet market requirements for fuel oil. Plans call for imports to be replaced eventually by production at Fawley.

Completed:

Skelly Oil Company has completed a new catalytic reforming unit at its El Dorado, Kansas, refinery and gradually is easing the 8500-barrel-a-day facility into production. A similar unit is in operation at Skelly's Longview, Texas, plant, and a third is under construction at Denver.

Oelweke Julius Schindler, GmbH, has put a new furfural lubricating-oil extraction unit on steam at its 4300-barrel-a-day refinery at Hamburg, Germany. The new unit was built for a daily capacity of 900 barrels.

Esso Standard Oil Company has completed a fluid Hydroforming unit at its Baton Rouge, La., refinery. The new unit will produce up to 25,000 barrels a day of high-octane gasoline for blending into motor and aviation fuels.

Constructed by C. F. Braun & Company, the unit and its associated off-site facilities cost the Esso company $12,800,000.

The Baton Rouge Hydroformer is the largest of three such units being started up by members of the Standard Oil Company (New Jersey) group. Others are at Wakayama refinery in Japan and at the Amuary Bay refinery in Venezuela. In addition, a

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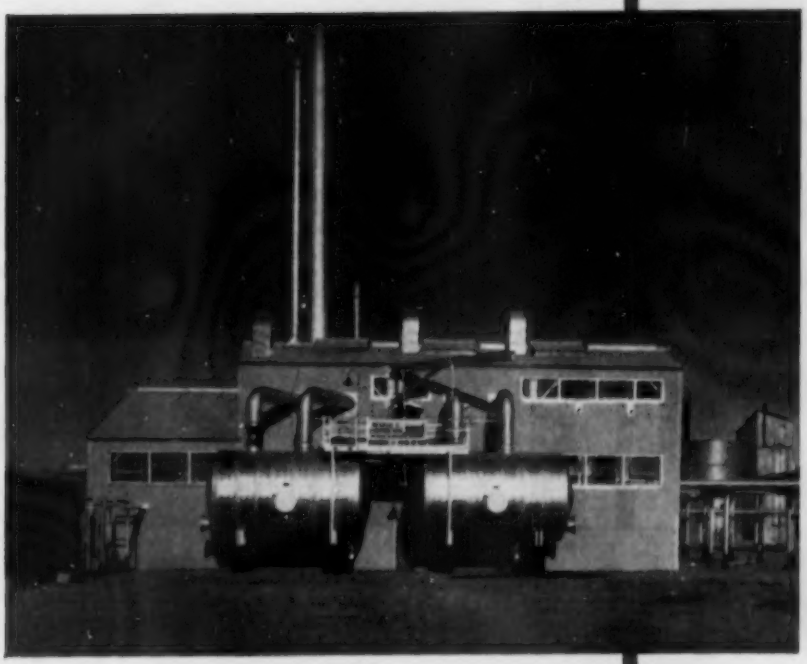
CANADA'S LARGEST H_2S SULFUR PLANT



Shell Oil Company of Canada, Limited recently placed on stream a plant that recovers over 50 tons of sulfur daily from hydrogen sulfide in natural gas. Located at Jumping Pound, Alberta, this is one of 21 domestic and foreign sulfur plants for which contracts have been awarded to Parsons.

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Who's Building . . .

fixed-bed Hydroformer is under construction at Baltimore, Md.

The Venezuela unit, built for Creole Petroleum Corporation, was completed for a daily capacity of 10,000 barrels. New construction at Esso Standard's plant in Baltimore includes, in addition to the 3000-barrel-a-day Hydroformer, Hydrofining equipment geared to handle 17,000 barrels a day, plus a 10,000-barrel-a-day fluid coker.

Foster Wheeler built the Hydroforming and Hydrofining units at Baltimore, as well as the unit at Amuary Bay.

Allied Chemical & Dye Corporation has finished an expansion program at its plant in South Point, Ohio, calling for enlarged capacities of the Nitrogen division's formaldehyde- and urea production units, together with a new formaldehyde urea concentrate plant. Principal contractor was The Girdler Company.

Compania Espanola de Petroleos has placed a Platformer in operation at its Tenerife refinery in the Canary Islands. Designed to produce an 88 F-1 clear octane blending component, the 5000-barrel-a-day unit is processing Middle East and Venezuelan crudes.

Integrated with a Udex unit, the Platformer runs on a blocked-out operation to produce alternately high-purity benzene and toluene and motor fuel blending material.

The Texas Company has a new combination Platforming-Unifining unit on steam at its Eagle Point Works in Westville, N. J. The Unit, with a daily capacity of 12,000 barrels, is the fourth such installation completed recently at Texaco refineries.

Other units are in operation at El Paso, Amarillo and Port Arthur, Texas. Another unit is under construction at Port Arthur, as well as at three other company refineries in the U. S. and at a subsidiary's plant in Montreal, Quebec.

The units are designed and licensed by Universal Oil Products Company, which also is handling the engineering. Construction at the New Jersey refinery was handled by Procon, Inc., was in charge of construction at the New Jersey refinery.

Sinclair Refining Company has a new 16,000-barrel-a-day catalytic reforming unit on steam at its East Chicago, Ind., refinery. The $13-million unit, built and put into operation in less than 11 months, uses a platinum catalytist developed by Sinclair and Baker & Company.

Sinclair recently placed a similar unit in operation at its Marcus Hook, Pa., refinery. A third such unit is under construction at the company's Houston refinery.

Imperial Oil, Ltd., has completed a major expansion program at its Montreal refinery. The project included the installation of a 41,000-barrel-a-day atmospheric pipe still and an 11,000-barrel-a-day vacuum still, together with additions to the plant's existing catalytic-cracking facilities.

The company also has completed engineering and awarded a contract for construction of a catalytic-polymerization unit and naphtha fractionator at its Ioco, B. C.,

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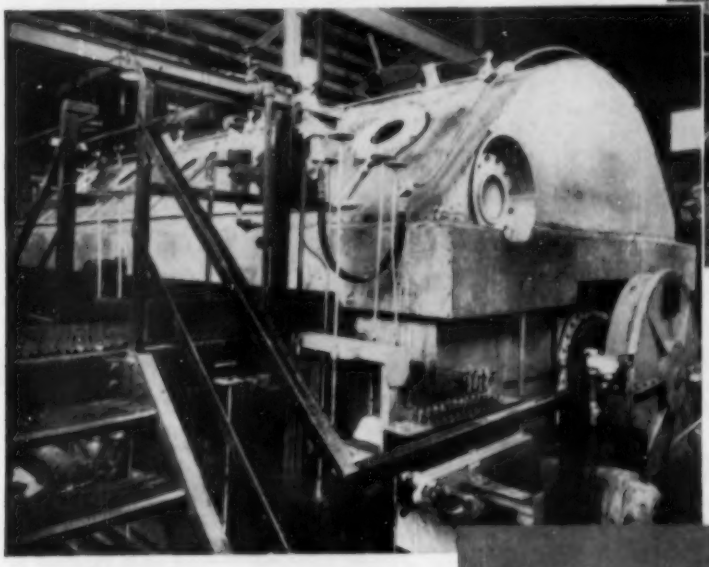
FLUID CAT CRACKER

CB&I built the reactor-regenerator and catalyst hoppers for the UOP fluid catalyst cracking unit shown above at the Rock Island Refinery Corp., Zionsville, Indiana, refinery.



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These filters are specifically designed for the clarification filtration of oil solvent mixes for the recovery of slack wax in refinery MEK solvent dewaxing plants. They are also applicable to product wax recovery from recrystallization filtration of slack wax with concurrent removal of product wax and soft waxes from low cold test oils.

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For more data on advertised products, use Readers' Service Cards, last page.

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961-2

Who's Building. . .

refinery. Bechtel Corporation's Canadian affiliate is expected to complete the $2.9-million project by October.

At Imperoyal, near Halifax, Imperial has another expansion program underway. New facilities, due to go into operation in November at a cost of between $25 and $30 million, will give the plant a daily capacity for 41,600 barrels.

Construction of a 2000-barrel-a-day lube oil plant at Edmonton, Alba, is proceeding on schedule, with completion set for July. Also progressing are modernization and expansion programs underway at the company's refineries in Sarnia, Ont., and Vancouver, B. C.

Refineria de Petroleos de Escombreras, Spanish affiliate of California-Texas Oil Company, has completed a lubricating oil plant at its refinery in Escombreras. Foster Wheeler Corporation was in charge of engineering and construction on the plant, built to produce 27,500 tons a year.

Gelsenberg Benzin, A. G., has gone into operation with its second Platformer at the refinery in Gelsenkirchenhorst, West Germany. The new $7.5-million unit, with a capacity of 7100 barrels a day, processes naphtha from Saudi Arabian crude and hydrogenated gasoline.

The refinery has a daily crude capacity of 39,000 barrels. Processing equipment includes a 10,000-barrel-a-day catalytic cracker and a 14,000-barrel-a-day hydrogenation unit.

Licensed by Universal Oil Products Company, the Platformer was built by Procon, Ltd., and Lurgi Gesellschaft.

Gulf Oil Corporation has put a new 16,000-barrel-a-day catalytic-reforming unit on steam at its Philadelphia refinery. The first of four Platformers being built for Gulf, the unit is processing naphtha, boiling in the range of 275 to 395 F.

It is producing 97.5 F-1 leaded debutanized reformate from a mixture of naphthas averaging 18 to 20 percent naphthene content. The reformate is being used as a blending compound for premium gasoline.

Other Platformers being built for Gulf are at Toledo and Cincinnati, Ohio, and Port Arthur, Texas. Respectively, they have daily capacities for 10,000, 70,000 and 29,000 barrels.

British-American Oil Company has completed a 2000-barrel-a-day catalytic reforming unit at its refinery in Calgary, Alba. The Fluor Corporation, Ltd., was in charge of building the unit, constructed under design specification by The Atlantic Refining Company.

A second catalytic reformer is planned for British-American's Montreal refinery. The 13,000-barrel-a-day unit, expected to be finished late in 1955, will be built by The Lummus Company.

Sinclair Refining Company has placed a new catalytic reforming unit on steam at its East Chicago, Ind., refinery. This is the second catalytic reformer completed by the company in recent months.

Built for a daily capacity o f16,000 barrels and now operating at its designed thruput, the new unit is expected to duplicate a similar reformer that went on steam

For more data on advertised products, use Readers' Service Cards, last page.

SALT LAKE REFINERY

The Houdriflow Catalytic Cracking Unit of the Salt Lake Refining Company has been consistently handling charge rates well above the 13,000 BPSD design reactor charge rate since going on stream in 1950. In 1952 this installation served as a test unit for studies in catalyst travel. Radioactive beads were introduced into the reactor, and their subsequent movements were checked by Geiger counters. These tests proved that the catalyst circulated through all parts of the Houdriflow unit with excellent uniformity.

Houdriflow units are now operating at the highest conversion levels ever achieved in the industry. An informative new brochure describing the Houdriflow process is available on request. Write to: Houdry Process Corporation, 1528 Walnut Street, Philadelphia 2, Pa.

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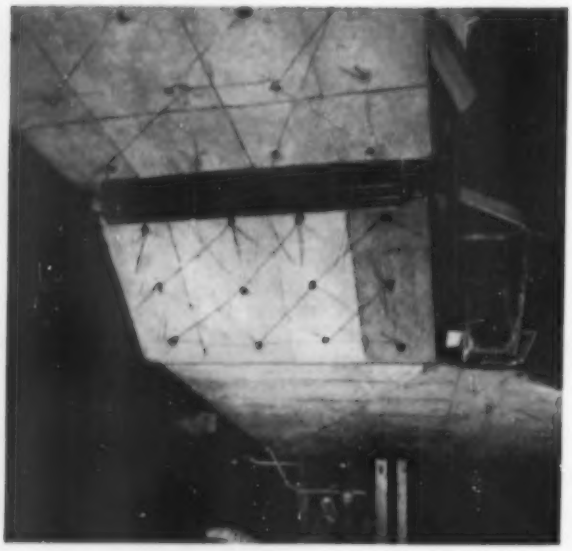
with the NEW *"Precision-Finish"*



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GREAT STRUCTURAL STRENGTH! Eagle-Picher PV Supertemp Block meets your specific demands for long-lasting insulating block able to withstand a wide hot surface temperature range up to 1900 F. PV Block effectively resists steam and other moisture, does not disintegrate or lose thermal efficiency under heavy-duty service.

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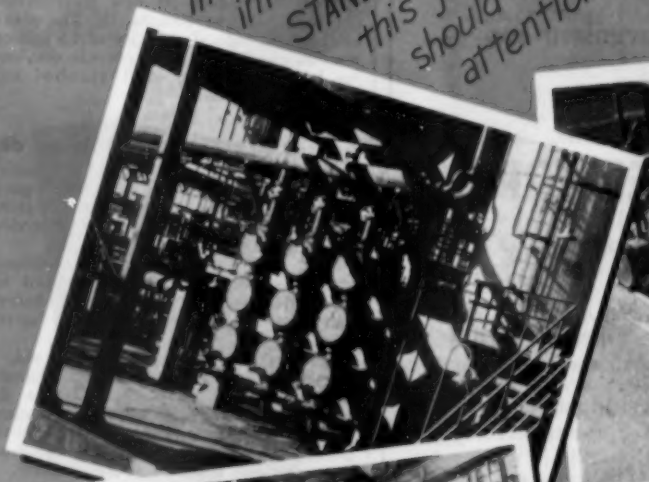

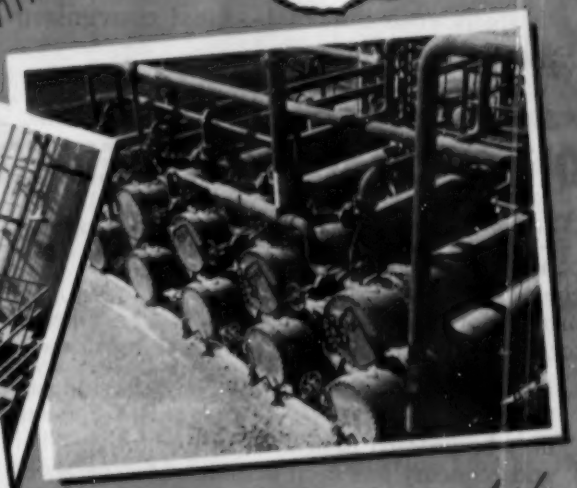

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Who's Building...

last October at Sinclair's Marcus Hook, Pa., refinery. That unit was operated continuously for about four months on its initial run before a short shut-down for minor structural revisions.

A third reformer is under construction at Sinclair's refinery in Houston. All three units use a platinum catalyst developed by Sinclair Research Laboratories, Inc., and Baker & Company, platinum specialists.

Petroleos Mexicanos has completed a $20-million expansion of its refinery at Poza Rica. Additions include duplication of the refinery's gas-absorption facilities, now yielding 10,000 barrels a day more gasoline, and a new propane plant, producing 3000 barrels a day.

The hydrosulfuric acid and carbon dioxide capacities were doubled, and equipment was installed to give the 200-ton-a-day sulphur-producing plant capacity for an additional 40 tons. Other new facilities include storage and cooling tanks, a water-purification plant, fire-fighting equipment and yard pipe lines.

National Petro-Chemicals Corporation has placed its new polyethylene plant on steam at Tuscola, Ill. The plant, built for an annual capacity of 25 million pounds, cracks ethane to provide ethylene for its polyethylene, ethyl alcohol and ethyl chloride units.

Societe Industrielle Belge des Petroles has put a 3000-barrel-a-day catalytic-polymerization unit into operation at its refinery in Antwerp, Belgium, and is due to complete a 10,000-barrel-a-day fluid catalytic cracking plant.

New construction, including additional distillation facilities also scheduled for completion soon, will raise the refinery's daily crude capacity from 36,000 barrels to 56,000.

The refinery, now three years old, is owned by British Petroleum Company, Ltd., and Cie. Financiere Belge des Petroles. Universal Oil Products Company licensed both the catalytic cracker and the polymerization unit, while The Lummus Company was engineer and contractor.

Pan American Refining Corporation has finished building its new research laboratory at Texas City, Texas. Made up of separate laboratories for high pressure, engine, analytical, process and product application research, the new center furnishes all research and development work for both the Pan American company, and its parent company, American Oil Company.

A total of 120 chemists and chemical engineers comprise the technical staff at the center. Research is already underway in both the petroleum and petrochemical fields.

British Malayan Petroleum Company, Ltd., part of the Royal Dutch Shell group, has opened a new natural-gasoline plant in North Borneo. The plant, built for a daily capacity of 2125 barrels, is linked by pipeline with the Lutong refinery in northern Sarawak, where the natural gasoline will be blended into refinery products.

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Pfaudler Data Book
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This 40-page, fact-packed manual is designed to help you solve heat exchanger problems. Contains all the data you need to work out capacity and type—arranged in easy-to-follow tables, curves and charts. Full details on Pfaudler heat exchangers. It's a basic working handbook which no one concerned with heat exchange should be without. Just mail the handy coupon for your copy.

Design features previously associated only with custom-built heat exchangers are now available at competitive standard cost under Pfaudler's new system of flexible standards.

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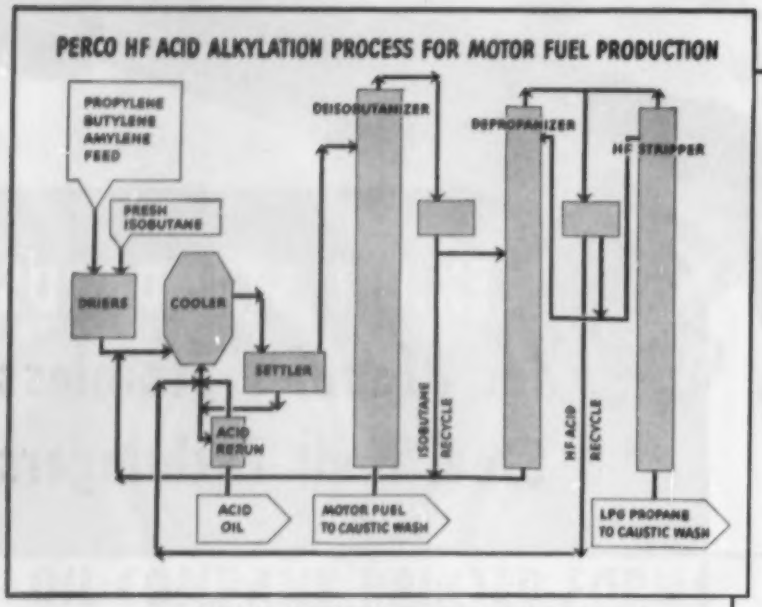

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3 Odorless, clean-burning fuel.

4 Creates no gum problem in any blend.

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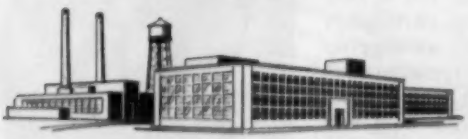
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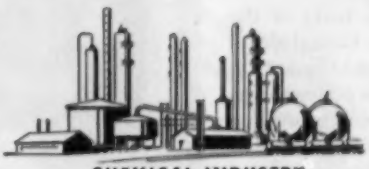
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CHEMICO

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How to Prepare an Annual Report

Are you putting enough emphasis on your annual report? Is it all it should be—a bright, factual human document? Does it work for your firm's good?

Weston Smith
Financial World
New York, New York

AN ANNUAL REPORT should be a colorful brochure, containing essential information required by stockholders and employes. It should be as carefully prepared as the company's most important sales promotional device.

Some managements are on the wrong track in attempting to utilize their annual reports as pure and simple sales brochures. The attempt to "sell" a bill of goods often involves self-praise, with an over-emphasis of the good and a soft-pedaling of the bad. Such a policy may produce immediate results, but in the long run it may prove to be a boomerang, particularly if management does not measure up to every claim made in the annual report. In essence, a good annual report is one that tells the truth, and tells it so the average member of society can understand it.

The best course is to make of the annual report a strictly factual document. Facts are the most eloquent exponent of a corporation's performance. Both the company's achievements and its problems should be disclosed. The latter, however, can be interpreted and clarified from the standpoint of management. It should be remembered that an annual report is primarily a review and not a forecast. Stockholders and others want to know how management is preparing for the future, but they do not expect any executive officer to assume the role of a prophet.

Walter S. Hallanan, president of Plymouth Oil Company, left, receives the bronze "Oscar of Industry" award for the best annual report of independent oil companies. Presenting the award is Weston Smith, originator and director of the annual report surveys in which 5000 reports were judged in the 1954 elimination.

Human Document—Properly prepared, a modernized annual report can be an interesting and convincing human document to weld together, for the general good of the corporation, all the human elements upon which it depends. Who are these elements? They are the public (customers), stockholders (including prospective investors), employes, distributors and dealers, bankers, newspaper editors and financial writers. A well-rounded annual report will build confidence in a corporation's securities.

Logically, the annual report can be

About the Author

WESTON SMITH, (see photo in accompanying article) is the originator and director of the Annual Report Surveys which have provided a measure of the progress in corporation reporting since 1941. A pioneer in the techniques of stockholder relations, he introduced the "Oscar of Industry" awards for the best annual reports in each industry in 1945. During the past 14 years he has read and rated more than 60,000 reports of about 5000 corporations, banks and mutual institutions.

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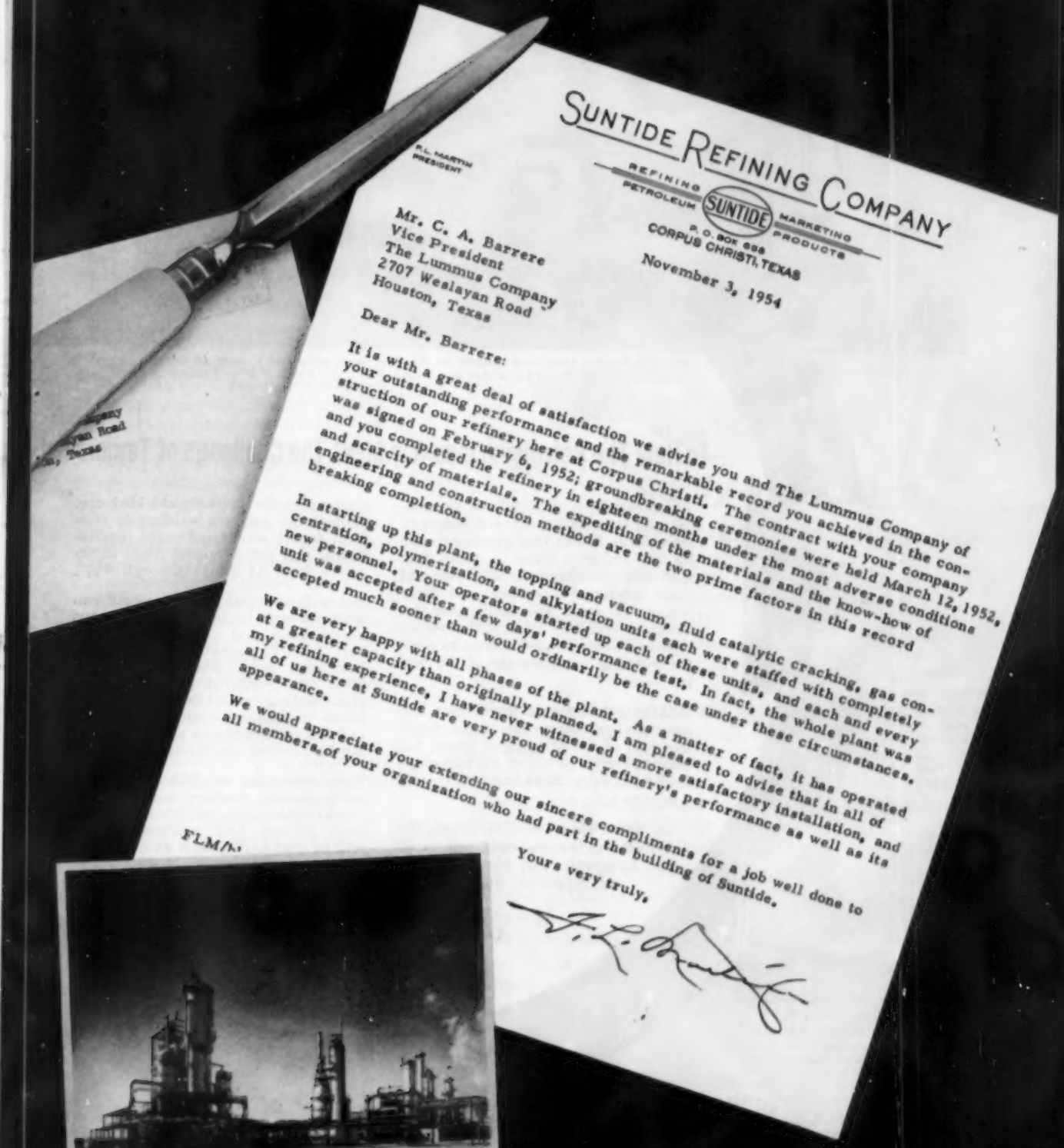
DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES



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REFINING PETROLEUM SUNTIDE MARKETING PRODUCTS

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P. L. MARTIN
PRESIDENT

November 3, 1954

Mr. C. A. Barrere
Vice President
The Lummus Company
2707 Weslayan Road
Houston, Texas

Dear Mr. Barrere:

It is with a great deal of satisfaction we advise you and The Lummus Company of your outstanding performance and the remarkable record you achieved in the construction of our refinery here at Corpus Christi. The contract with your company was signed on February 6, 1952; groundbreaking ceremonies were held March 12, 1952, and you completed the refinery in eighteen months under the most adverse conditions and scarcity of materials. The expediting of the materials and the know-how of engineering and construction methods are the two prime factors in this record breaking completion.

In starting up this plant, the topping and vacuum, fluid catalytic cracking, gas concentration, polymerization, and alkylation units each were staffed with completely new personnel. Your operators started up each of these units, and each and every unit was accepted after a few days' performance test. In fact, the whole plant was accepted much sooner than would ordinarily be the case under these circumstances.

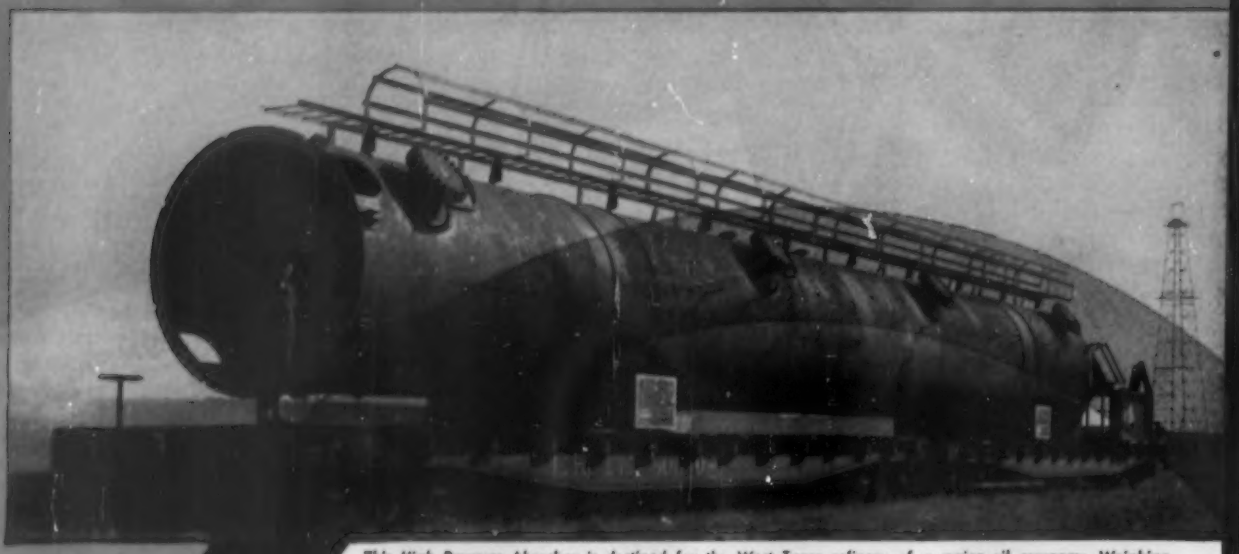
We are very happy with all phases of the plant. As a matter of fact, it has operated at a greater capacity than originally planned. I am pleased to advise that in all of my refining experience, I have never witnessed a more satisfactory installation, and all of us here at Suntide are very proud of our refinery's performance as well as its appearance.

We would appreciate your extending our sincere compliments for a job well done to all members of your organization who had part in the building of Suntide.

Yours very truly,

FLM/b

Custom Fabricated Pressure Vessels . . .



This High Pressure Absorber is destined for the West Texas refinery of a major oil company. Weighing more than 197,000 lbs., it has a shell plate thickness of 1.52", and is 7'-6" in diameter by 82'-3" long.

. . . To Help The Petroleum Industry Meet The Challenge of Tomorrow!

On its way from our Oklahoma City plant to an Illinois refinery via three railroad flat-cars, is this 4'-6" by 140' "Long John." Its total weight is only 56,000 lbs.

Bound for a Gulf Coast refinery is this 124,000 lb. pressure vessel, fabricated by BS&B. With over-all dimensions of 13' by 137', three flat-cars are required to transport it.

The technology of petroleum processing and refining has come a long way since we built our first pressure vessel for the industry some 25 years ago. But with development of newer and more advanced processes and techniques has come the challenging demand for specially fabricated pressure vessels of complicated design to meet the exacting requirements of the new processes.

BS&B, with some of the largest and most modern custom fabrication facilities west of the Mississippi River, has become known as one of the industry's leading quality fabricators of custom equipment.

In our Oklahoma City plant, for instance, we are equipped to do automatic and semi-automatic submerged arc, automatic and semi-automatic inert-gas-shielded arc, manual arc and gas welding to conform to all recognized code requirements, and can fabricate plate thicknesses from 14 gauge through 4½".

Our well-equipped machine shops can fabricate both ferrous and non-ferrous alloys, solid and clad materials. In our 2300° F. annealing oven we can heat treat units measuring up to 80'-0" in length, 15'-8" in diameter and weighing up to 125 tons. The very latest in quality control, inspection and testing techniques and equipment are in constant use throughout.

Take advantage of BS&B's conveniently located modern facilities and years of fabricating experience on your next project! Our representatives will be glad to discuss it with you in strictest confidence. Or write to . . .

Contract Sales Division, Dept. 5-F5

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2131 Westwood Blvd. P. O. Box 1714 Oklahoma City, Oklahoma

a corporation's most effective forum for developing the confidence of stockholders, employes, customers and the public. Yet today two-thirds of all American corporations, including some in the oil industry, are backward in their annual reporting, as measured by the simplest of standards for presenting adequate financial statistics and understandable yearly reviews of the business.

It is generally recognized that every corporation has three classes of stockholders:

- The active supporters.
- The indifferent observers.
- The unfair critics.

The last mentioned class will have little to complain about while earnings are on the upgrade and dividend payments are reasonable, but when operations become less favorable and dividends are reduced or deferred, then the critics will be heard. The influence of this aggressive minority which is often uninformed about the true facts of its corporation, can prove disastrous during a proxy fight, not only to management but to the best interests of all concerned.

On the other hand, managements enjoying a majority of "active supporters" among their shareholders, because they have explained their problems in full, will survive an earnings setback or dividend reduction. When stockholders have confidence in the ability and sincerity of the officials of their corporations, they will retain their holdings even during an extended business recession.

It is worth emphasizing that the majority of the readers of annual reports probably did not finish high school, and that it is estimated that more than 50 percent of all stockholders are women — two powerful reasons why the corporation annual report must be attractive to look at, easy to read and financially understandable to the average small investor. Because the annual report is recognized as an important medium of public relations, it is prepared to influence opinion and build the prestige of the management rather than to advertise or sell merchandise or services.

It is easy to mangle an annual report in the production; in inexperienced hands it has happened too often. Some of the elements on which expert advice is needed are: paper,

easily installed in split-case pumps

This new addition to the "JOHN CRANE" family of anti-corrosive Type 9 Seals is the answer to a simplified means of seal installation (or removal) in modern split-case pumps.

Need for unbolting the upper half of the casing is eliminated, since the unit is mounted on a sleeve with an outside clamping ring.

Sealing members of DuPont Teflon readily adapt this seal to the handling of chemicals, solvents and corrosives, plus high temperature and similar conditions under which rubber cannot be used.

Springs and metal parts are furnished in the metallurgical specification best suited to the service.

Wherever "hard-to-handle" liquids or gases are involved . . . temperatures from −90° to +485°F . . . pressures to 750 psi . . . the "John Crane" Type 9 Seal is *the* seal for your pump.

Get complete facts and engineering data on the "John Crane" Type 9 Packaged Seal with outside clamping ring. Contact Crane Packing Co., 1820 Cuyler Avenue, Chicago 13, Ill. *In Canada: Crane Packing Co., Ltd., 617 Parkdale Ave., N. Hamilton, Ont.*

*DuPont Trademark

JOHN CRANE CRANE PACKING COMPANY

For more data on advertised products, use Readers' Service Cards, last page.

As Management Sees It . . .

printing processes, illustrative techniques, printing colors, type faces, type sizes, type combinations and type area. The appearance of any report can be ruined by trying to combine certain printing processes or kinds of art work with certain type faces.

Favored Size—Last year's reports ranged in trim size from 3 inches x 5 inches to 9 inches x 12 inches. The smallest, of course, often are an invitation to eyestrain, and limit the statistical tables. Intended to be carried handily in the pocket, they are rarely considered as a digest magazine. The majority of reports (66.8%) measure 8½ x 11—letter size, for easy filing. This favored size has added advantage of wide pages, allowing long unbroken lines for comparative balance sheets and statistical tabulations. If letter size is used, however, the editorial text should be broken up into two columns. Long lines of type across a wide page tend to become illegible unless set in large type. There is a certain definite maximum to which type of a given size may be set and beyond which both its attractiveness and readability are impaired. Of course, margins should be in proportion to the size of the page.

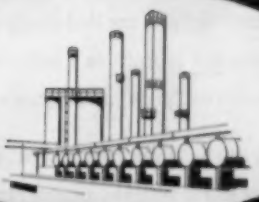
The typographic appeal of the annual report is important. More than two kinds of type are rarely advisable or necessary. Type faces as used in books will prove more satisfactory for annual reports than those favored for advertising purposes. Because dignity is a primary consideration, type should be just a medium of communication —neutral enough to let the message come through. Another factor to remember in choosing an appropriate type face is the method of reproduction to be used. The same face will appear quite different in offset from the way it does in letterpress. Several otherwise perfect specimens in last year's survey of reports were spoiled by unsuitable combinations of types and reproduction processes.

Selection of colors should be decided with regard to appropriateness, legibility and good taste. They should be chosen particularly with a view to the ways in which they can be economically applied to reproduction in halftone, tint-block and line cut. Effects which can be achieved by a second color are limitless if handled effectively. The extra color, of course,

For more data on advertised products, use Readers' Service Cards, last page.

here
a pressure drop is annoying

here
a pressure drop is expensive



here's how

GLOBE SEAMLESS ALLOY WELDING FITTINGS ASSURE MINIMUM PRESSURE LOSS!

A CIRCULARITY — True circularity throughout insures accurate alignment when special odd-angle sections are cut. Full diameter throughout protects against pressure loss due to flattened or angular surfaces.

B RADIUS — Uniform gradual change of direction provides smooth even flow — less resistance to directional changes.

C SMOOTH INNER WALLS — No waves or ridges within the fitting to impair flow—no buckling of metal along the short inner curve—no stretching on the outer curve. This prevents premature piping system failure

D SMOOTH JOINTS — Uniform wall thickness, machined bevel ends, and perfect agreement between fitting and pipe sizes assure automatic and perfect alignment. The smooth welded joints present no interruption to flow.

Welding fittings remove all "road blocks" from the flow of material. They present a gentle transition in contour, smooth inner walls free of pockets or crevices within the joints. Flow of materials is speeded, erosion due to turbulence is minimized adding years to the life of the piping system.

This efficient piping flow reduces maintenance costs, reduces pumping power requirements and investment in equipment.

GLOBE SEAMLESS WELDING FITTINGS

GRADES: Carbon, Alloy and Stainless Steels.

TYPES: Elbows, Tees, Caps, Saddles, Laterals, Nipples, Returns, Flanges, Stub Ends, Reducers, Crosses, Bull Plugs.

SIZES: Complete range of sizes and schedules.

IT PAYS TO LOOK AT THE ADVANTAGES OF USING GLOBE SEAMLESS WELDING FITTINGS

Welded Construction Takes Less Space—Piping can be nested in corners, or fitted against ceilings, walls or equipment. Dimensional accuracy permits cut-offs at odd angles when necessary.

Whole Sections Can Be Shop-Fabricated—For fast installation, or where working space is limited, entire sections can be shop-fabricated and installed by any qualified welder in a few minutes.

Welded Construction is Easily Insulated — Insulation is simplified by the absence of complex flanged assemblies. Because joints are leakproof, insulation is permanent and maintenance free.

Welded Construction is Permanent — Maintenance costs are kept at a minimum because piping is permanent and leakproof. The strength of the weld approaches that of the pipe itself.

Welded Construction is Simple to Install—Dimensional accuracy of angles, radii, and bevels, assure quick and easy joining. Any qualified welder can do the job efficiently and economically.

Welded Construction is Lightweight—Strength with lightweight permits easy handling in installation. Unwieldy sections can be joined on the ground, and then quickly fastened into position.

THE *NATURAL* SOURCE FOR ALLOY FITTINGS

B&W TUBULAR PRODUCTS DIVISION

THE BABCOCK & WILCOX COMPANY
Tubular Products Division • Fittings Department
3839 W. BURNHAM STREET • MILWAUKEE 46, WIS.

FA-5902

District Sales Offices: BEAVER FALLS, PA. • BOSTON 16, MASS. • CHICAGO 3, ILL. • CINCINNATI 6, OHIO • CLEVELAND 14, OHIO • DETROIT 26, MICH. • HOUSTON 19, TEX. LOS ANGELES 17, CAL. • MILWAUKEE 46, WIS. • NEW YORK 16, N. Y. • PHILADELPHIA 2, PA. • ST. LOUIS 8, MO. • SAN FRANCISCO 3, CAL. • SYRACUSE 2, N. Y. • TULSA 3, OKLA.

The true cost of an expansion joint is not the figure on the manufacturer's price tag. Many factors enter into any such cost determination. For example, an expansion joint that fails just when it shouldn't could wreck a plant and cost a small fortune. And, assuming equal first-cost of any two competitive manufacturers' designs, one that stands up twice as long as the other . . . costs only half as much on a unit-time basis. So, one really shouldn't count on "price" as a measure of value.

But here is one thing you can count on. Every single expansion joint in the Zallea line is designed and built to assure maximum reliability —and top value for your dollar. This is no empty boast, but a fact that can be confirmed for you by figures.

So, whenever you have problems—or needs—relating to expansion joints, don't fail to get in touch with Zallea. Write today for Bulletin 351, containing condensed descriptions of the many types. There is a Zallea joint for every requirement.

Zallea expansion joints

ZALLEA BROTHERS, 890 LOCUST STREET, WILMINGTON 99, DELAWARE

World's Largest Manufacturers of Expansion Joints

should be used in charts. It may also be utilized for heads and subheads, if it is strong enough to carry. If not, it may appear in tint blocks behind the heads, subheads or charts, as reverse plates or as duotone plates behind half-tones, etc. If the second color is selected for subheads, those headings must be in a fairly heavy type to avoid becoming too pale in comparison with the rest of the text.

Choosing Art—Illustrations have a definite place in both industrial corporation and financial institution reports. They depict the products or services of a company and explain figures and statistics. They should not, however, be included merely as embellishments. When photographs are used, it is considered good public relations to show "informal" pictures of both employes and company officers and pictures of products in the process of manufacture or finished products in use. Each photo should carry a suitable caption.

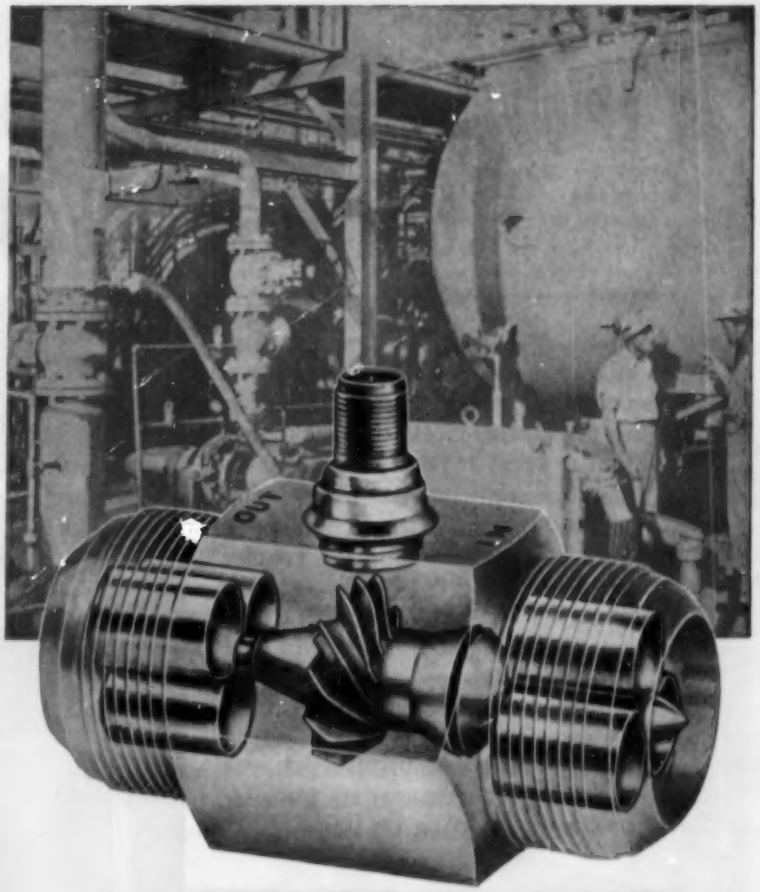
There are many varieties of symbols available for use in charts. But almost everyone who prepares an annual report utilizes the same symbols to illustrate financial and operating statistics: line and bar charts, coins, stockholders' certificates and wedges of pie. These have the advantage of being readily comprehensible, but they have passed the point of being unique or original. Maps can be utilized for a variety of purposes: locating plants, distributors, agents and branches in and outside of the U. S., plus sources of raw materials, transportation routes, etc.

Here are the primary requirements of a well-rounded annual report that will help to improve readability and continuity:

I. **Cover Design:** A dramatic photograph of other illustrations, appropriate to the corporation or industry represented—one that will attract interest or arouse curiosity to look iside of the annual report.

II. **Management:** Clarification of the duties of each officer of the corporation and the identification of each member of the board of directors.

III. **Table of Contents:** A listing by page numbers of all ediorial and financial material, as well as significant charts, maps and other illustrations. An alphabetical index of informative



Potter Electronic Flow Meters measure acids, caustics, suspensions at high or low temperatures and pressures with great accuracy!

if the question is flow

the answer is Potter

● Potter Electronic Sensing Element with turbine-type "floating rotor" generates current whose frequency is directly proportional to flow rate. Inherently linear element has extremely wide rangeability, low pressure drop.

New Potter Electronic Flow Meters are used for accurate, foolproof, continuous measurement and control of hard-to-handle liquids with an accuracy of ± ½% of true flow over the recommended range. Supplying information in terms of weight or volume, they are efficient at temperatures from —450 to 1200°F and under pressures as great as 35,000 psi. Further advantages are swift, economical installation, low maintenance.

There are complete Potter Flow Meter Systems, including Recorders, Indicators and Digital Totalizers to meet your specific needs.

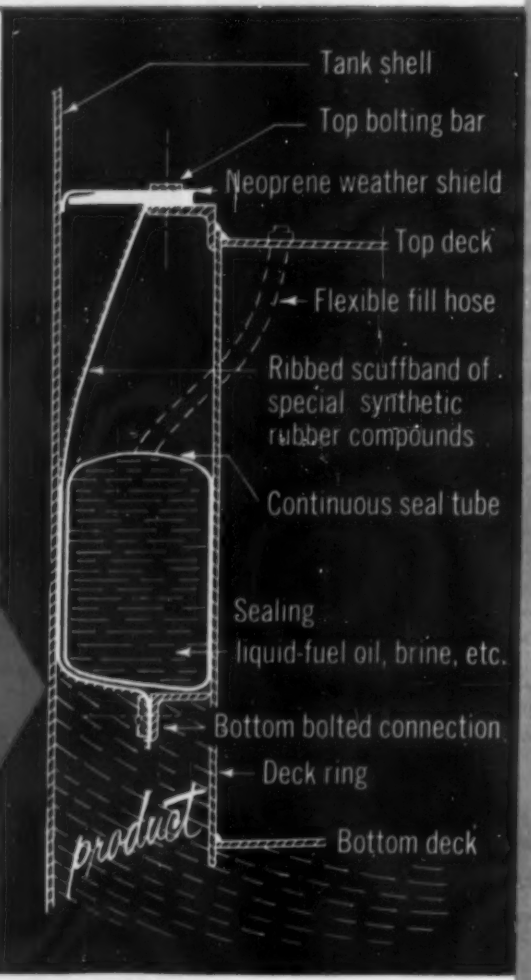
Write for Bulletin LS-1

Potter **POTTER AERONAUTICAL COMPANY**
Route 22 • Union, New Jersey • Phone MUrdock 6-3010
makers of Potter engineered products

For more data on advertised products, use Readers' Service Cards, last page.

Think of what this means to operators of FLOATING ROOF TANKS!

Elimination of potential vapor-loss and preservation of product quality, the most important reasons for a floating roof tank, are now reality . . . the **HAMMOND TUBESEAL,*** for floating roof tanks of welded or riveted construction, provides the most efficient and positive seal known . . . sealed at a point to prevent vapor space between roof, rim and shell, thus there is no room for vapors to form or for the product to come in contact with outside influences and be contaminated . . . the **TUBESEAL*** has no moving parts, requires no maintenance, adjusts for tank out-of-roundness, is climate proof and non-corrodible, can operate to bottom of tank or above the top . . . **ITS ENTIRE CIRCUMFERENCE IS TIGHTLY SEALED UNDER PRESSURE AT ALL TIMES . . . NO VAPOR SPACE BELOW THE SEAL.**



THERE'S NO ROOM FOR VAPORS TO FORM WITH THE HAMMOND TUBESEAL

THE **HAMMOND TUBESEAL*** HAS BEEN THOROUGHLY TESTED IN COMMERCIAL USE . . . IT IS **GUARANTEED** TO YOUR SATISFACTION.

HAMMOND TUBESEAL COSTS NO MORE IN THE FIRST PLACE

*Copyright

ask for Bulletin TS

CHEAPER OVER THE YEARS

HAMMOND IRON WORKS

WARREN and BRISTOL, PA. • PROVO, UTAH
CASPER, WYO. • BIRMINGHAM, ALA.

Sales Offices: NEW YORK 20 • AKRON • BOSTON 10 • BUFFALO 2 • CHICAGO 3 • CINCINNATI 2 • CLEVELAND 15
EL PASO • EUSTIS, FLA. • HOUSTON 2 • LOS ANGELES 14 • PITTSBURGH 19 • RICHMOND 20 • SAN FRANCISCO
WASHINGTON 6, D.C. • HAVANA • MEXICO CITY • "TIPSA" BUENOS AIRES Licensee in Cal.: LACY MFG. CO., LOS ANGELES

and statistical features should be included in larger annual reports running as many as 24 pages or more.

IV. **Highlights:** A panel of comparative statistics, properly explained, to show the year-to-year trend of essential facts, such as earnings per share of common stock, dividends paid, financial position, etc.

V. **President's Letter:** A one-or-two-page message, crisply written for easy reading, omitting all superlatives and generalizations but including some comments on future prospects.

VI. **The Narrative Section:** The review of the year written in a colorful and human style, and divided by subheads which describe the true contents of each section. Appropriate photographs and charts can be selected to illustrate this section, including an income-outgo chart, a pie chart or other graphical device to show at a glance the major sources of revenues and how the income dollar is distributed.

VII. **Simplified Financial Statements:** A condensed balance sheet and income account that is complete enough to provide a true picture of the financial position of the corporation at the close of the fiscal year, as compared with that of the previous year.

VIII. **Stockholder and Employe Information:** Charts and tables of the number of stockholders over a period of years, and statistics according to average size of holdings, geographical distribution, by sexes, etc. Records of the average number of employes over the years, with statistics on average hourly rates for skilled workers, the capital investment per employe, etc.

IX. **Statistical Comparisons:** Operating and financial statistics should be provided for at least ten years, and more if possible. A chart should not be considered as a substitute for the actual figures—both should be provided. Other important statistics are the changes in capitalization during the past decade or longer, the retirement of funded debt and the trend of net working capital, with the working capital ratio. Such tabulations should enable the stockholder to figure the value of his shares, and the laborer to find out the source of his weekly earnings. As a suggestive list, the following may be mentioned:

1. Total net sales, with breakdowns by divisions when appropriate, plus other income.
2. Total operating expenses, cost of sales should be shown separately from salaries, wages and payroll.
3. Total net earnings before and after taxes.
4. Total taxes paid, showing separately Federal, State and local levies.
5. Taxes per share.
6. Taxes per wage dollar.
7. Net earnings per share.
8. Dividends per share.
9. Net worth per share.
10. Percentage of earnings on sales.

Some such list as the foregoing, covering a minimum of ten years, with adjustments for the kind of business involved, should be presented in the back of the report on two facing pages, set in type of an easily readable size.

One reason for these basic statistical tables is to enable the security analysts, investment advisers and the large stockholders to compute certain important indexes of efficiency—the operating ratios and rates of turnover as follows:

1. Ratio of expense to net earnings (operating ratio).

As Management Sees It . . .

2. Turnover of total capital used—the ratio of total sales to total money employed in the business.
3. Turnover of fixed capital.
4. Turnover of net worth.
5. Turnover of inventories.
6. Turnover of accounts receivable—the average "collection period."

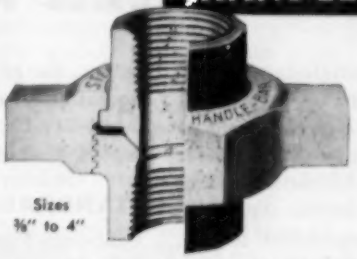
Such ratios supply the real tests of management, and the complete annual report should at least supply the basis for computing them for a series of years.

Preparation of the annual report cannot be left to an amateur, and should not be the part-time job of a senior executive who has no public relations sense or understanding of its use. In the last analysis the best in a modernized annual report should be prepared with the cooperation of the controller who knows how to reach and interest the readers of these documents, whether they be stockholders, employes, customers, security analysts, investment advisers or the public.

Next Month: How annual reports are judged. ##

PRESSURES AND TEMPERATURES are SAFE in these

"HANDLE-BAR" 4000 TEST



Sizes ⅜" to 4"

FORGED STEEL UNIONS

A skillfully engineered seat design provides the perfect seal for holding securely rated temperatures and pressures. Advanced manufacturing methods, rigidly controlled step by step to maintain the highest standard of quality, produce these accurately finished, rugged Handle-Bar Unions.

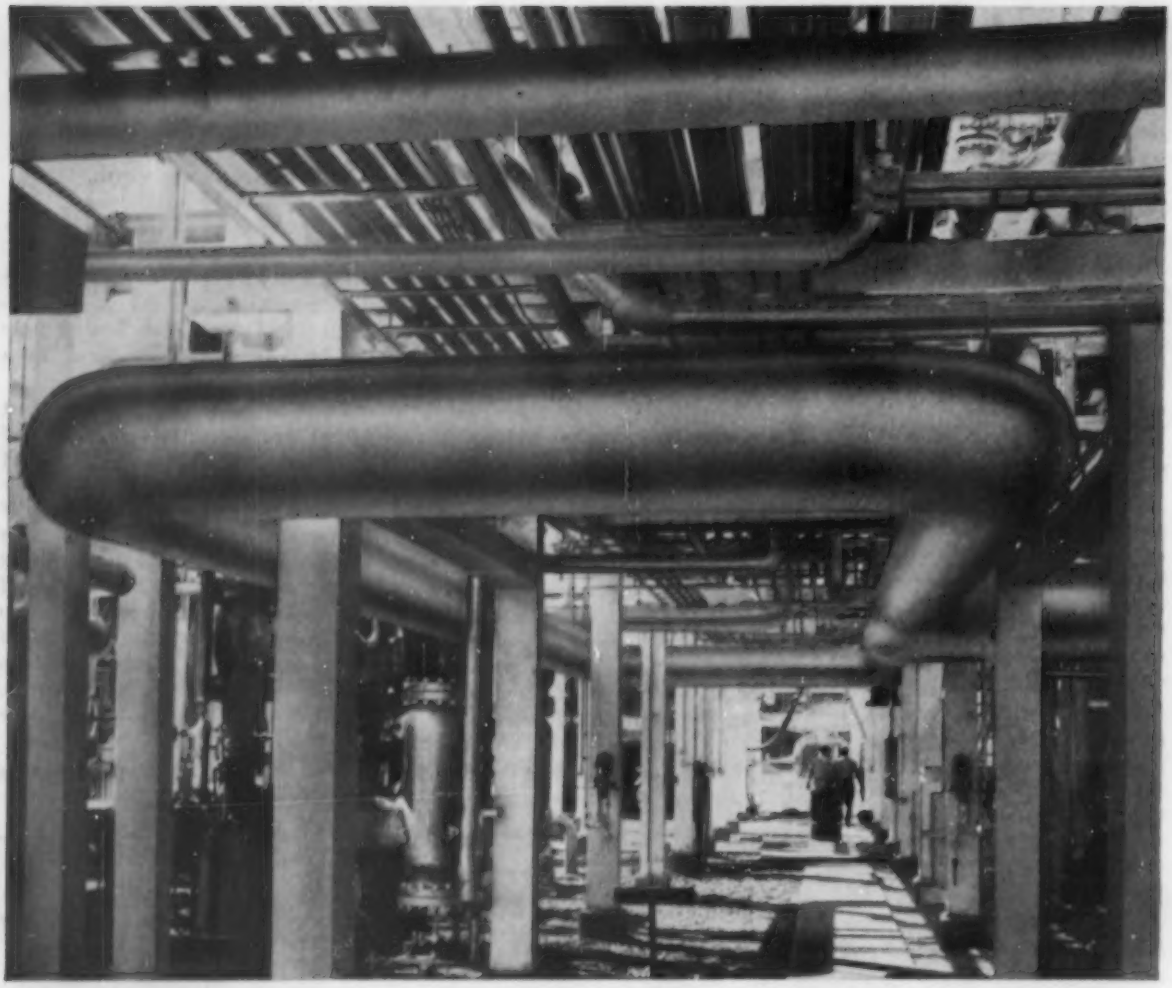
Quick and Easy to Make and Break because the nut threads are permanently lubricated with Udylite Cadmium. The Extra Heavy Nut provides the strength necessary to withstand rough handling and excessive abuse. So Great in Value . . . So Low in Cost.

WRITE TODAY FOR OUR FREE, NEW, COMPREHENSIVE CATALOG

Clayton Mark & Company

1900 DEMPSTER STREET EVANSTON, ILLINOIS U.S.A.

For more data on advertised products, use Readers' Service Cards, last page.



Less heat loss at joints with single-layer Unibestos® Pipe Insulation

Tests prove that Unibestos single-layer pipe insulation actually provides greater protection than other nonfibrous *double-layer* insulations which cost more to install. Unibestos is made of Amosite—the long-fibered African asbestos. These fibers interlock with one another to prevent heat loss at horizontal and longitudinal joints.

While most insulating materials show a pronounced shrinkage at high temperatures, Unibestos has no measurable shrinkage at 1200°F. It will not powder, pulp or wash off, even under heavy moisture conditions, and when dry, Unibestos resumes its original thermal and physical characteristics.

EASY to install . . . easy to remove.

Unibestos can be cut, mitered and handled easily. The fabrication of insulation for tees, valves, flange covers, etc., is a fast, low-cost operation. Because of its unusual strength and durability Unibestos can be removed and replaced with little or no loss of material.

STANDARD PRODUCTION SIZES

Unibestos Pipe Insulation is regularly made in 3-foot lengths for pipe sizes from ½″ through 24″, in standard thicknesses through 5″. Unibestos Block Insulation is made in 6″, 12″, 18″ or 36″ widths and in thicknesses from 1″ through 3″ in ½″ increments.

For complete information, write for descriptive Bulletin 109C

UNARCO

UNION ASBESTOS & RUBBER COMPANY

1111 West Perry St. • Bloomington, Ill.

They Speak Up for Du Pont

With 'blue magic' in their hands and chemical progress on their minds, they spread the word about company and industry.

AN ADMIRING listener once called him a "combination Herb Shriner and Albert Einstein."

He is Louis P. Shannon, who as manager of the Extension Division of E. I. du Pont de Nemours' Public Relations department is the chief oracle of a different and highly successful concept of how to make friends for his industry and his company.

The traditional approach to public relations is the enhancement of a company's good name through all available media.

Du Pont's Extension Division varies this procedure by going directly to the public with the entertaining story of how scientific research contributes to the nation's progress. Last year Shannon and his six associates spoke 859 times before a combined audience of 136,089. In addition, there were 37 radio and TV appearances.

Groundwork for the Division of Extension was begun in 1936 by Larry F. Livingston of the Explosives department, who delivered a number of speeches on the industrial use of agricultural raw materials. Almost every major farm magazine in the country asked for copies of his talks, and soon he was receiving many invitations to speak.

One request took him to Omaha, where the president of the Union Pacific heard him. A little later Du Pont's president received a letter from the railroad executive: "Keep this man at this type of work." Du Pont endorsed the suggestion.

Louis P. Shannon

Something to talk about

Blue Magic—Because he found it easier to speak with something in his hands, Livingston had taken five samples of products to the Omaha meeting. He had walked on the platform with them wrapped in a blue velvet cloth, as he had seen magicians do. If he noticed a lessening of attention, he whipped out a new product. It worked like magic.

"Within an hour after that speech," Livingston recalls, "I had five invitations to speak and 'to bring those things along.' "

This experience taught him that people like to see and touch new products of research. At one time or another until his retirement last December, he took with him enough new products to fill an 18-foot table.

In 1938, Livingston became manager of the Agricultural Extension Division of the Public Relations de-

At
PACIFIC TUBE
you can get the
LONGEST LENGTHS
of **COLD DRAWN**
SEAMLESS STEEL
TUBING made!

EXTRA LONG STRAIGHT LENGTHS... UP TO 58 FEET!

A major expansion of facilities at Pacific Tube...with new hydrostatic testing and pickling equipment and the largest drawbench in the West...enables us to produce in quantity, *extra length* quality tubing.

Our strategic Western mill location enables us to serve you efficiently, economically and promptly.

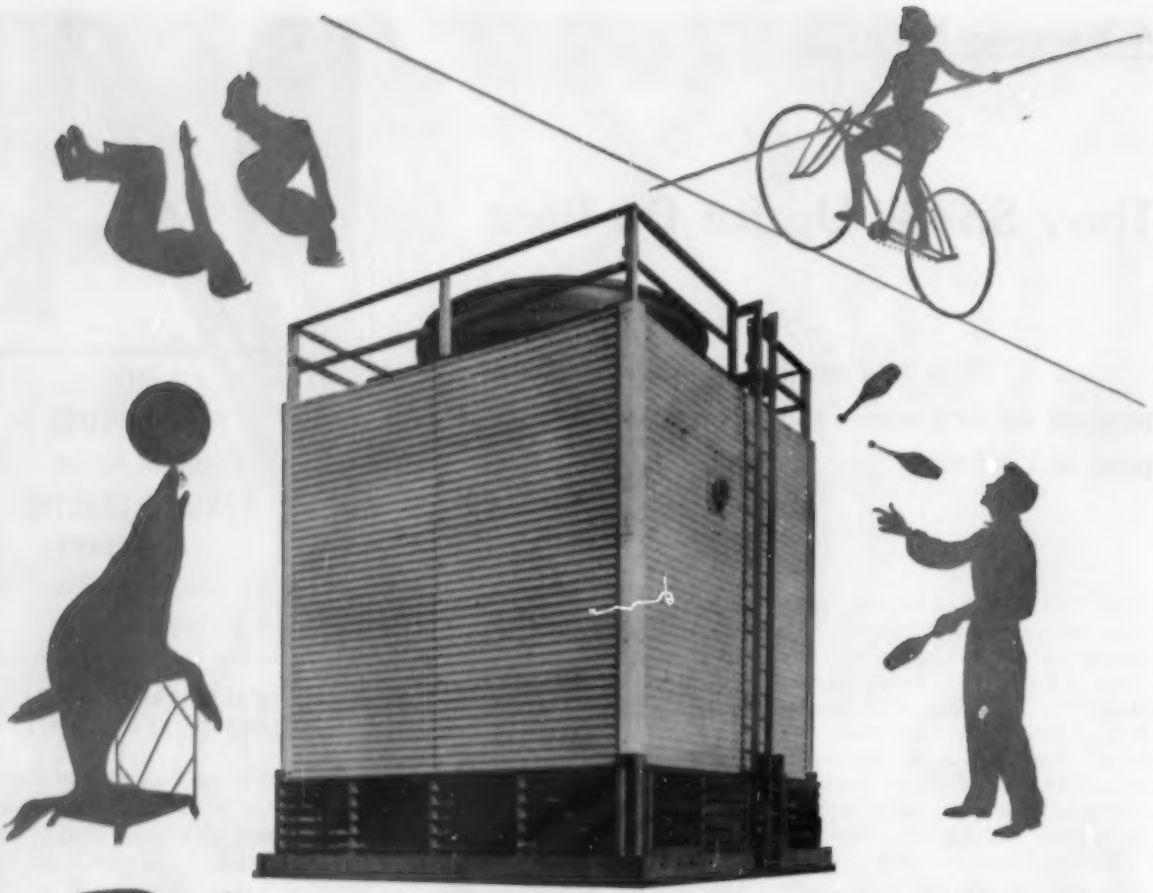
Pacific Tube Company specializes in the manufacture of tubing from stainless, carbon and alloy steels. Producing cold drawn seamless tubing, welded tubing and cold drawn bars.

Call or write today for detailed tubing information.

Pacific
TUBE COMPANY
Manufacturers of
STEEL TUBING AND BARS

5710 SMITHWAY STREET
LOS ANGELES 22, CALIF.
Telephone RAymond 3-1331
Our movie...
"Steel Tubes for Industry," available without charge.

For more data on advertised products, use Readers' Service Cards, last page.



Balance, too, is important in

COOLING TOWERS

In the new CW SERIES COOLING TOWERS Marley engineers have achieved a high performance level that takes these counter-flow towers out of the "conventional" class. A carefully balanced expansion of three major elements results in more cooling ability for every frame size. CW towers offer:

GREATER FILL VOLUME – with more wetted surface in each cubic foot

GREATER AIR VELOCITIES – more pounds of air to pick up heat

GREATER SPRAY BREAK-UP – high pressure down spray on closer centers

There is the correct amount and type of fill to balance the increased air velocity; proper spray pressure to perform adequately with added fill and air flow. Of greatest importance is the skillful integration that makes the expanded features perform at a new low cost per gpm. This balance carries through to the fan, Geareducer, fan cylinder and drive shaft, all Marley designed to function as a unit at higher velocities for longer life.

MARLEY

The Marley Company

Kansas City, Missouri

partment. The function of the new division was to inform farmers about the chemical industry and how it could help them. Gradually, more requests came from members of the audience who wanted a speaker for a Rotary luncheon or a Chamber of Commerce dinner. The work of the division broadened, and in 1941 it became simply the Extension Division. Today, the audiences are as diverse as the population of the country. Only about 5 percent are exclusively farm groups.

Such is the demand for speakers that the Extension Division has established regional offices at Chicago, Memphis and San Francisco, each staffed with a speaker and a secretary. The staffers' backgrounds are dissimilar, which permits greater flexibility to meet the requests to talk before many kinds of groups.

• Shannon is a former educator with a broad experience in personnel relations and industrial engineering. He handles most of the requests for speakers to technical societies and educational groups.

• Beth Peterson is a graduate home economist with a background of teaching, radio broadcasting, and extension work.

• Paul R. Leach, Jr., is a former Washington correspondent for McGraw-Hill publications.

• Robert T. DeVore is a veteran Washington reporter and editor for the Washington *Post*.

• Wyatt F. DeLoache has had wide experience as a writer, editor and United Press reporter.

• Harlan L. P. Wendell recently rejoined Du Pont after a year as a public relations advisor to Mrs. Oveta Culp Hobby, member of the President's Cabinet.

• James Adshead, Jr., is a former radio and television newscaster and program director.

Says Shannon of his job: "Representing Du Pont management is a never-ending challenge. We must continually keep abreast of research and development at Du Pont and how they, as part of the American business system, contribute to progress in this country.

"Besides, I like people and I love to talk to them." ##

the new TOUGHER
GENERAL PURPOSE
PLASTIC PIPE

ACE-ITE is a new moderately priced rigid plastic pipe with exceptional impact strength and toughness . . . handles most corrosive fluids in your plant at moderate temperatures and pressures.

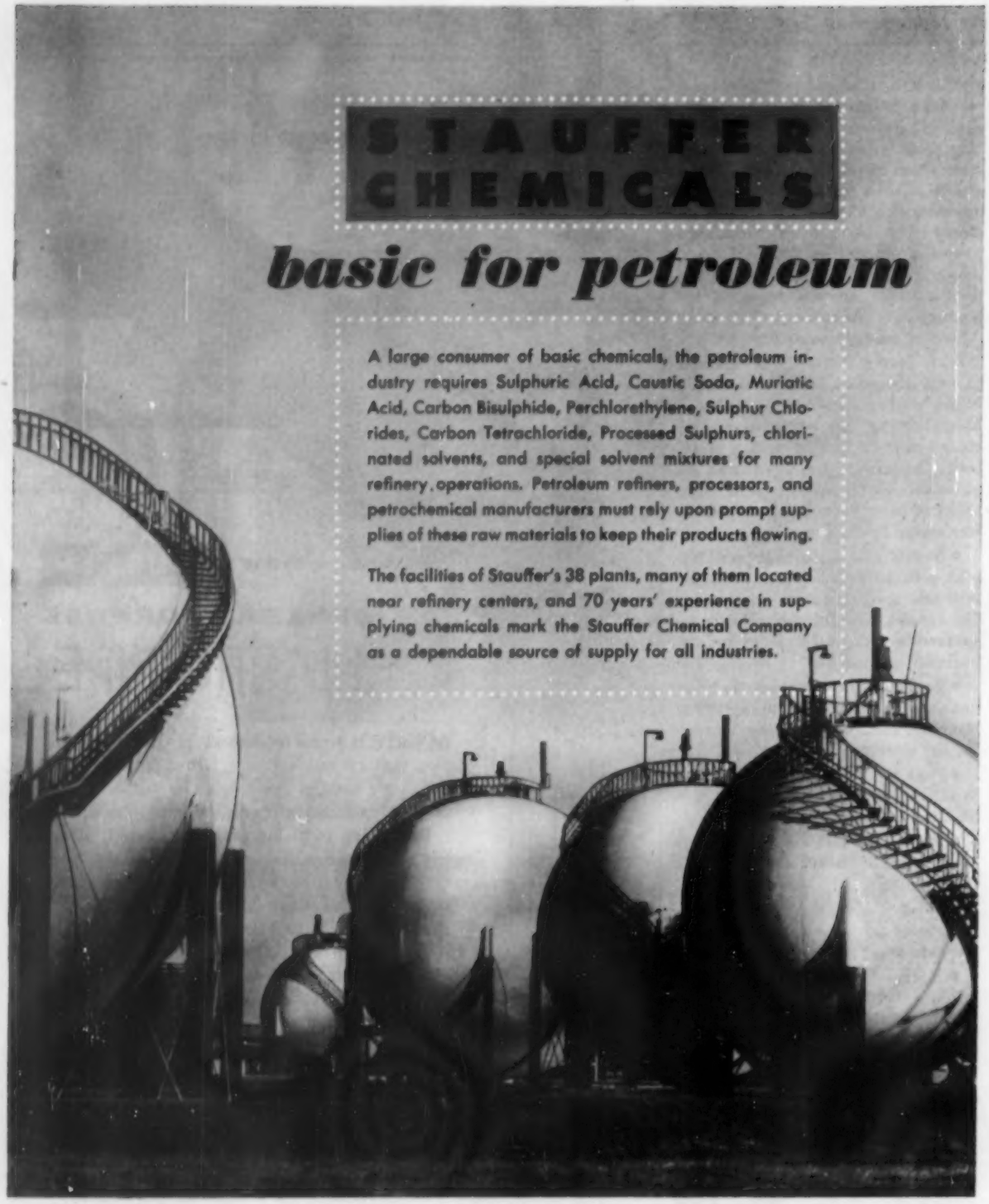
For piping most inorganic acids, salts, alkalis and many organic chemicals, it's the equal of plastics that cost far more. ACE-ITE maintains good strength, rigidity and chemical resistance from minus 40 deg. F. to 170 deg. F. Light in weight, it is odorless, tasteless, non-contaminating. Saves cost of painting, immune to electrolytic corrosion and bacteria. Available in pipe sizes from ½" to 6", standard and extra-heavy, with wide variety of fittings.

ACE-ITE is only one of eight types of rubber and plastic pipe now offered by American Hard Rubber Company. Write today for free technical Bulletin 80.

ACE rubber and plastic products

AMERICAN HARD RUBBER COMPANY
93 WORTH STREET • NEW YORK 13, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.


STAUFFER
CHEMICALS
basic for petroleum
A large consumer of basic chemicals, the petroleum industry requires Sulphuric Acid, Caustic Soda, Muriatic Acid, Carbon Bisulphide, Perchlorethylene, Sulphur Chlorides, Carbon Tetrachloride, Processed Sulphurs, chlorinated solvents, and special solvent mixtures for many refinery operations. Petroleum refiners, processors, and petrochemical manufacturers must rely upon prompt supplies of these raw materials to keep their products flowing.
The facilities of Stauffer's 38 plants, many of them located near refinery centers, and 70 years' experience in supplying chemicals mark the Stauffer Chemical Company as a dependable source of supply for all industries.

380 Madison Avenue, New York 17, N. Y.

221 N. La Salle St., Chicago 1, Ill. • 636 California St., San Francisco 8, California
326 S. Main St., Akron 8, Ohio • 824 Wilshire Blvd., Los Angeles 14, Calif.
8901 Hempstead Road, Houston 8, Tex. • North Portland, Ore.

STAUFFER Stauffer CHEMICALS CHEMICALS

SINCE 1885

As Management Sees It . . .

Philnews Drawing

When Phillips Goes Shopping . .

MANURE AND MACHETES. Tin cans and tetra-ethyl lead. Cold cream, candle molds and clown suits.

These are some of the items on the shopping list of an integrated oil company. Pumps, for instance, represent a sizable investment. Phillips Petroleum Company spent $8½ million last year on pumps of various sizes, types and specifications.

Most unusual purchase made by Phillips' 18 buyers is the annual order for a rail carload of horse manure. This item is used at the Kansas City refinery for packing around water line valves during freezing weather.

Rabbits, hamsters, white mice, chickens, dog food, milk, bananas, beer, soda pop, shortening, fly larva, marbles and BB's are purchased each month for the Bartlesville agricultural testing laboratory.

Many unusual requisitions are received daily from the Alaska and Venezuela operations. Some of the more exotic include sleeping bags, peach nectar, chicken feed, mules, candle molds, saddles, barber chairs, juke boxes, pool tables, baby formula, geiger counters, guns, caskets, ammunition, dress goods, machetes and artichoke hearts.

Phillips also buys castor oil to lubricate gas compressors; cold cream, wooden shoes and zipper conveyor belts for carbon black plants; epsom salts for water treating, and goldfish for water testing. Thousands of items such as bubble gum, balloons, suckers, money clips, key chains, paperweights, model airplanes, clown suits and orchids are purchased regularly for promotion work.

On and on the list goes—horses, canary birds, locomotives, elevators, volcanic ash, pipe cleaners, dye, bath tubs, chicken brooders, pig troughs—even eucalyptus tree extract, imported from Australia as a drilling mud additive. ##

in the petrochemical industry

"HEAT EXCHANGERS BY Paracoil"

is a WELL KNOWN and RESPECTED "BY-LINE"

It means specialized experience in the fabrication of completely integrated heat exchanger units that are

Dependable in performance . . .
Rugged in construction . . .
Designed for easy service . . .

For many years we have been building

Solvent Recovery Equipment
Extraction Coils
Evaporators
Reaction Vessels
Condensers (for any Vapor)
Solution Heaters & Coolers
Exhaust Waste Heat Boilers
Quenching Oil Coolers
Storage Tank Heaters
Fractionating Equipment
Self-Cleaning Heat Exchangers & Gas Coolers

A stainless steel Reflux Condenser, floating head construction. Paracoil" designed and built.

Our staff of chemical and mechanical engineers is available for consultation in solving your problems on

STANDARD HEAT EXCHANGERS
SPECIAL EQUIPMENT
PILOT PLANT UNITS OR
PLANT MODERNIZATION PROGRAMS

We cordially solicit your inquiries.

DAVIS ENGINEERING CORPORATION

1044 EAST GRAND STREET, ELIZABETH 4, NEW JERSEY — 30 ROCKEFELLER PLAZA, NEW YORK 20, NEW YORK

New! Patented! Reversible Superstructure

Now Possible —

TREMENDOUS SAVING OF REVERSAL TIME
(Only 7 Minutes Required)

- Superstructure Remains in Place
- Plug Stem — Spring Stem Coupling Undisturbed
- Body Stays in the Line

CONSOLIDATION OF SPARE PARTS

- Direct and Reverse Topworks Identical
- Plugs Pinned to Seat Upward or Downward as Required

HAMMEL-DAHL COMPANY

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SALES OFFICES IN ALL PRINCIPAL CITIES

MANUFACTURING PLANTS IN WARWICK, R. I., U. S. A., CANADA, ENGLAND, FRANCE AND HOLLAND

CANADIAN MANUFACTURING AFFILIATE—GUELPH ENGINEERING CO., GUELPH, ONT.

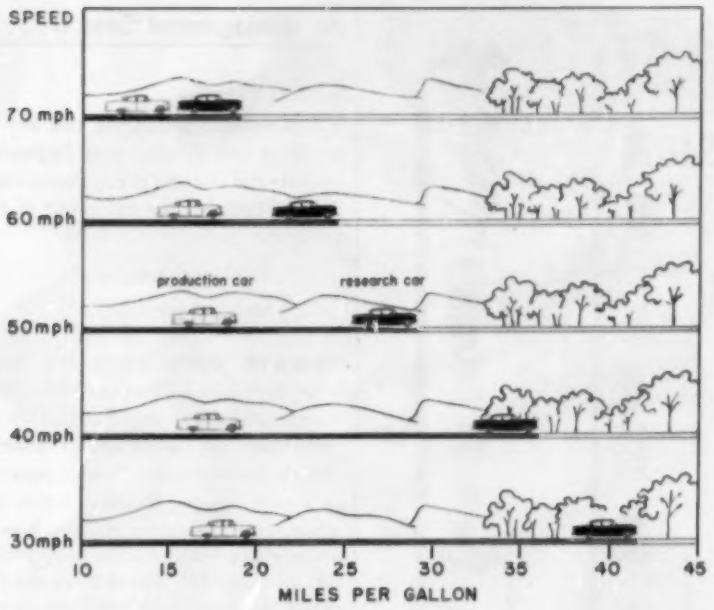


FIGURE 1—This chart shows fuel consumption related to speed. The Research Car (with theoretical "no loss" between engine and driving wheels) vs. the Production Car. Conditions: Constant speed, flat road proving ground.

Safe Driving Cuts Costs

Seven rules of safe driving are listed for automobile drivers who want to save lives and money.

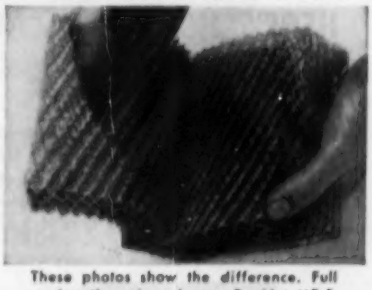
R. J. West,
Fort Worth, Texas

SAFE DRIVING is economical driving.

Reduce speed and you save fuel and tires. Easy starts and careful stops lead to a reduction in accidents.

Experience proves an increase in percentage of tire life attainable at lower speeds. It provides sufficient reasons for steps to be taken to reduce road speeds to planned limits.

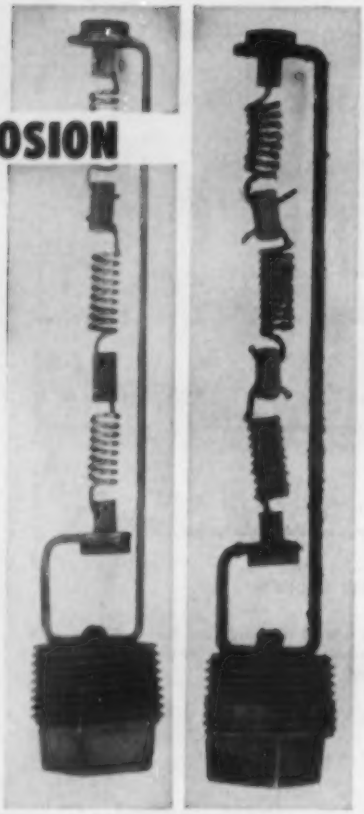
Excessive fuel. Excessive fuel consumption is also indicative of unnecessary expenses resulting from high speeds, faulty driving habits or poor maintenance. As fuel consumption is reduced by bringing car speeds down to legal limits or lower, the accident curve comes down in even greater proportion. The fuel consumption chart clearly demonstrates that greater fuel economies are realized at the more reasonable speeds. Here again is sufficient reason to reduce road speeds

now...
more effective
and economical
ENTRAINMENT
SEPARATION
with the
NEW HI-THRUPUT
HERRINGBONED
MIST ELIMINATOR
Check these important points:
1. Half the pressure drop of Standard Mist Eliminator.
2. Safe operating limits – 10% to 12% higher velocity.
3. Entrainment removal practically 100% over wider operating range.
4. Three to four times longer on-stream life under coking conditions or where solids are present.
5. Lower cost – wires repositioned by Herringbone Fold*.
*U.S. Patent No. 2,565,846, Aug. 28, 1951

These photos show the difference. Full explanation given in our Booklet ME-5.

Send for Revealing Booklet ME-5. Learn how repositioning wires by patented Herringbone process and change in size and contour of mesh openings make this new Mist Eliminator more effective and economical.
METAL TEXTILE
CORPORATION
Roselle, New Jersey
Metal Textile Corporation of Canada, Ltd., Hamilton, Ont.

For more data on advertised products, use Readers' Service Cards, last page.

HERE'S HOW RETURN LINE CORROSION REDUCES POWER PLANT EFFICIENCY...



Return line corrosion is one of the most critical problems in maintaining economical, efficient power plant operation. To demonstrate what corrosion can do in steam and condensate return lines, we show here "before" and "after" unretouched photographs of N.D.H.A. Corrosion Testers. This is a test* developed by the American Society for Testing Materials in cooperation with the National District Heating Association. Bird-Archer supplies and analyzes these testers. Photo at left shows a Tester before installation. Photo at right shows a Tester after it had been installed for 60 days in the return line. (*Standard Method of Corrosivity Test of Industrial Water, NDHA Method, ASTM Designation 935-49).

HERE'S HOW YOU CAN ELIMINATE THIS WASTE WITH AMINE TREATMENT

Bird-Archer Amine Treatment is an easy, effective and economical way to eliminate corrosion troubles. Amines raise the pH value of the return condensate to the point whereby the corrosion potential is negative. In addition, amines provide a surface protection for the metal itself which further inhibits corrosion. In scores of plants, Bird-Archer Amine Treatment is paying a profit on its cost through savings in piping replacement and maintenance work.

WRITE FOR
BULLETIN CP-100
AND THE NAME OF THE BIRD-ARCHER SERVICE ENGINEER NEAREST YOU.

BIRD-ARCHER
WATER TREATMENT
THE BIRD-ARCHER COMPANY, 4337 N. AMERICAN ST., PHILADELPHIA 40, PA.
NEW YORK • CHICAGO
IN CANADA: The Bird-Archer Co., Limited, Cobourg, Ontario
BIRD-ARCHER COMPANY OF CALIFORNIA, San Francisco

As Management Sees It . . .

to planned limits.

Professional driving is the key to accident-free driving and improving operational economy. Professional driving methods are the result of two factors:

(1) Trial and error and

(2) Method analysis.

Guarded skills. Over the years, some individuals develop driving skills which are as jealously guarded by the individual as a skilled craftsman guards his technique. Proper planning of a pass, figuring the other driver will always do something wrong, how to shift gears without clashing, proper use of gears for downhill braking in order to require a minimum assist from brakes, how to approach a blind intersection in the city or country, or a traffic light that might turn red, how to keep an area of defense on all sides of you, how to tell when and where not to pass at night, preventive driving for any situation—these are the prized hallmarks of the men who drive for a living.

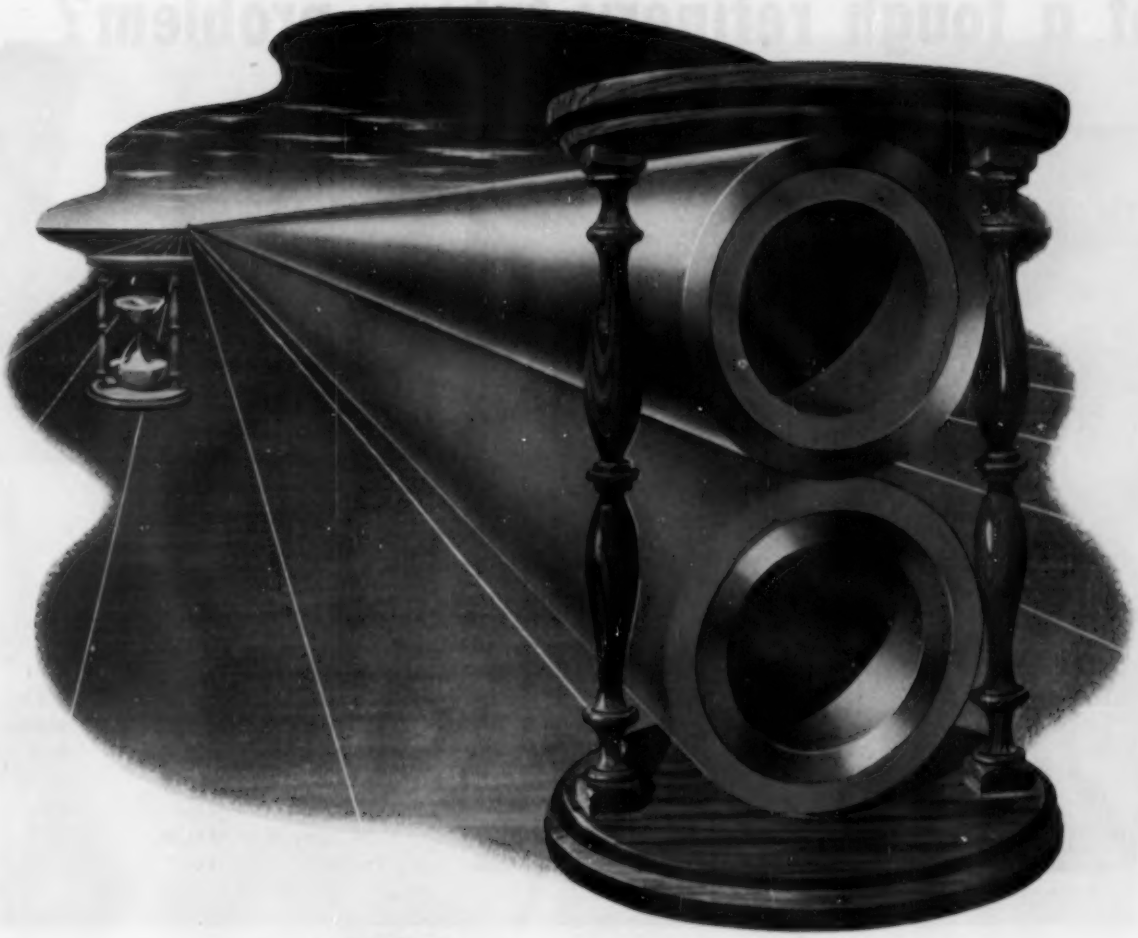
Analyzed methods are the results of:

- Specific study by traffic and safety engineers of particular driving situations.
- The development from these studies with the help of professional drivers of standardized driving methods to eliminate or reduce each driving hazard. These results are slowly finding their way into public driving habits and attitudes.

Habits and attitudes. Safe driving is a matter of habits and attitudes of the individual, therefore, for full effectiveness he must be contacted, instructed, motivated, and coached as an individual. Many persons believe they are expert drivers, so in order to determine best how an individual actually drives one must ride with him and observe his driving habits and attitudes.

The difficult task—and the one one managers must face directly if they are to obtain the full benefit from a cost reducing accident prevention program—is to acquire the know-how of translating their finding into

For more data on advertised products, use Readers' Service Cards, last page.



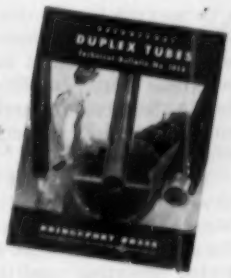
It's LAST cost that counts!

. . . and Bridgeport Duplex Tubes last longer

In the long run you save money with Bridgeport Duplex Condenser Tubes! Resisting different types of corrosion, inside and out, they eliminate the need for frequent retubing and shutdowns . . . often improve heat-transfer characteristics . . . reduce maintenance costs substantially when the proper combination of metals is used.

Bridgeport Duplex tubes are available in many combinations to match your service requirements. For example: copper-steel, cupro nickel-lead, red brass-aluminum.

Call your local Bridgeport Sales Office for complete information and the help of Bridgeport Technical Service. Ask for your copy of Bridgeport's Duplex Tube Technical Bulletin.



BRASS Bridgeport CO.

BRIDGEPORT BRASS

Offices in Principal Cities • Conveniently Located Warehouses
Bridgeport Brass Company, Bridgeport 2, Connecticut
In Canada: Noranda Copper and Brass Limited, Montreal

For more data on advertised products, use Readers' Service Cards, last page.

Got a tough refinery tubing problem?

National Tube's 25 Different Steel Tube Analyses:

Carbon	5 Cr, ½ Mo	18-8
Carbon, ½ Mo	5 Cr, ½ Mo, 1½ Si	18-8 Ti
½ Cr, ½ Mo	7 Cr, ½ Mo	18-8 Cb
1 Cr, ½ Mo	8 Cr, ½ Mo	18-8 Mo
1¼ Cr, ½ Mo	8 Cr, 1 Mo	25-20
2 Cr, ½ Mo	9 Cr, 1 Mo	3½ Ni
2¼ Cr, 1 Mo	12 Cr	5 Ni
2½ Cr, ½ Mo, ¾ Si	12 Cr, Al	
3 Cr, 1 Mo	17 Cr	

Our 25 different tubing analyses may hold the answer

NO MATTER how unusual your pipe or tubing problem, there's a good chance that one of our 25 analyses will solve it. Each of these analyses was developed to overcome actual conditions of exposure, corrosion, oxidation, temperature and pressure. Each has been thoroughly tested in refinery service, and we know exactly what each one will do.

Throughout the past 60 years, we at National Tube have built up an extensive file of authentic case histories. We gathered our information first hand by observing the actual performance of refinery tubes under the most trying operating conditions known to the industry. The answers to these problems have been boiled down into our 25 different analyses. Here they are for your use. Other chemical compositions are also available in tubular products, and a wide variety of high temperature problems are now under study.

Examine this list of steel tubing analyses. But before you decide which to use, let our engineers in on your problem. They'll welcome the opportunity to recommend the specific analysis that will do the best job at the lowest cost to you. For further details write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

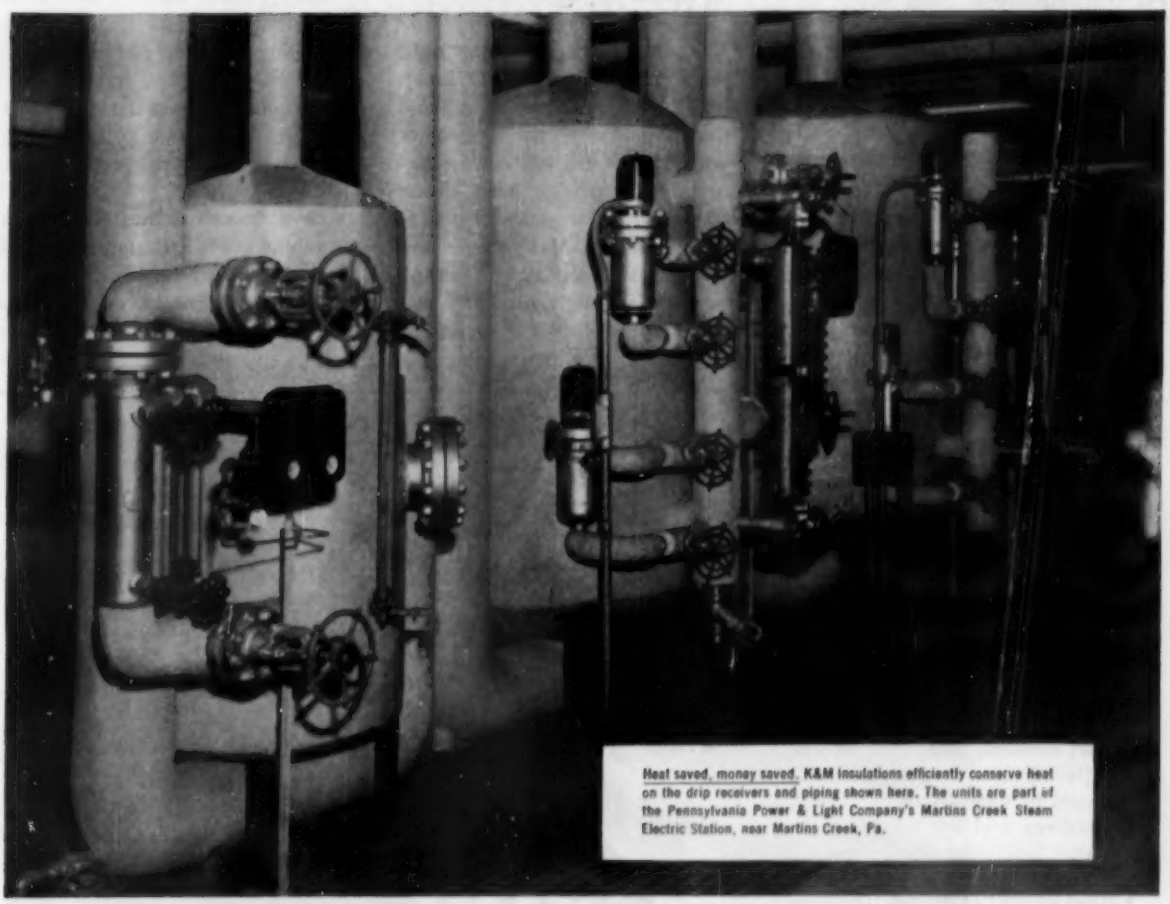
NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

NATIONAL SEAMLESS PIPE AND TUBES

WALLS WITHOUT WELDS

UNITED STATES STEEL



Heat saved, money saved. K&M insulations efficiently conserve heat on the drip receivers and piping shown here. The units are part of the Pennsylvania Power & Light Company's Martins Creek Steam Electric Station, near Martins Creek, Pa.

Keep Heat Losses Down with

K&M HIGH PRESSURE INSULATIONS!

Efficient heat conservation means *real* dollar savings. Get those savings by using K&M high pressure insulations—known for years for their exceptional efficiency in minimizing heat losses.

K&M "Featherweight"® 85% Magnesia and K&M Hy-Temp Insulation last the life of the equipment they serve. They withstand moisture, vibration, and frequent temperature changes. Both are supplied in various sizes and thicknesses. When used together, these materials—with staggered joints—eliminate the heat loss that normally occurs in single layer installations when expansion causes joints to open.

Efficiency to 1900° F. K&M Hy-Temp Insulation is used on applications where temperatures rise to 1900° F. It's made of diatomaceous silica combined with heat-resistant mineral fillers and asbestos fiber. Usually, it's applied in combination with K&M "Featherweight" 85% Magnesia.

Efficiency to 600°F. K&M "Featherweight" 85% Magnesia is used for effective insulation of piping and equipment with temperatures up to 600° F. 85% of this material is composed of basic carbonate of magnesia, the remainder of asbestos fiber.

Efficiency to 450°F. K&M "Featherweight" Water-Resistant Magnesia Insulation is used on equipment with temperatures up to 450° F. It is especially effective where severe water exposure may damage insulation, or where high humidity and moisture are present.

Act today. Don't let continued heat losses keep operating expenses piling up. Contact your K&M distributor for information on these insulations, or write directly to us.

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

K&M best in asbestos®

improved driver practices. Success is the continuous and systematic application of corrective measures based upon needs found by regular checking of drivers.

The problem is the same as teaching employes how to perform other jobs in accordance with approved and tested methods. Each manager or supervisor personally should learn how to perform the "pro" driving practices and honestly strive to practice professional driving as an example to all other employes.

Professional driving. A few professional driving practices which should be taught by managers are:

- **Speed within conditions, even on race tracks.** Take into consideration at all times the condition under which driving is done—the hills, hollows, traffic, weather, road surfaces, and drive accordingly. If one must speed, it should be done on an authorized speedway and not on the highway.

- **Keep an area of defense.** Drive on the defensive at all times, never expect the other driver to do the right thing. Don't expect them to stop at a red light or stop sign, but you be prepared to do so. Defend against the negligent acts of others.

- **Approaching a blind intersection, or signal light in the city or country.** Always expect someone to come out of a blind intersection, or run a stop sign, or red light—they do it and it causes many bad accidents.

- **How to pass a vehicle on the highway.** Always drive at a safe distance back of the car or truck immediately ahead. That way the road is visible for a long distance ahead and, when an opening is about to occur, you can gain momentum, using space between yourself and the other car. You will avoid continuously "sticking your nose out" until somebody hits it. Stay behind a minimum of ten car lengths at 50 m.p.h.

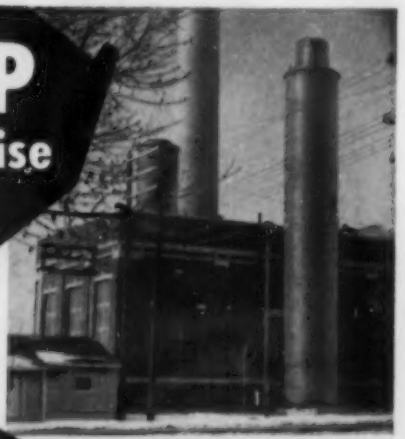
- **Use the proper lane (the right hand lane—the "expert" lane).** Always drive in the right hand lane even though the highway or street is not striped. Always signal when changing lanes, giving the other driver plenty of time to give clearance. Make a right turn always from the right lane. Always enter the right hand lane after completing the turn. The same is true when turning left, always make the left turn from the left hand lane and, on completing it, enter the left lane.

- **Signaling.** Always let the other driver know what you are going to do by giving the proper signal.

- **Be a smooth driver.** Avoid jack rabbit starts and stops, constant speeding up and slowing down. Know that you have full control of your vehicle at all times for any situation. ##

Here's How to STOP that noise

from air, steam and other gas discharges



and

STOP Pulsation and Vibration in gas and air piping

BURGESS-MANNING SNUBBERS

— are engineered to effectively correct your specific noise or pulsation problem.

They are available in many different basic types for arresting intake and exhaust noises, some of which may integrally incorporate such additional features as air cleaning — or heat recovery — or spark arresting — or surge control — or water separating.

Others, which are primarily designed to stop line surges set up by compressors, pumps, blowers, etc., will effect noteworthy savings in piping, repairs and maintenance, and permit accurate flow readings.

There is no obligation for recommendations. Send us a description of your problem.

Sound Engineering

BURGESS-MANNING COMPANY

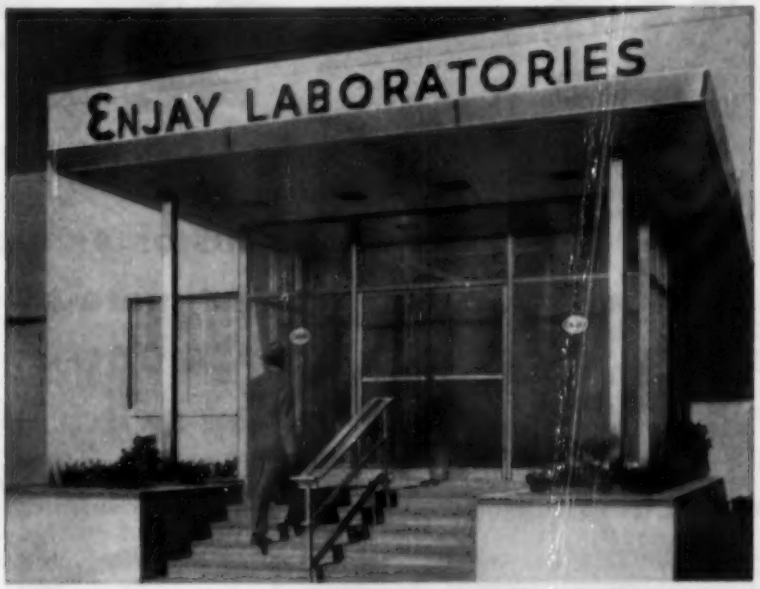
711 East Park Avenue, Libertyville, Illinois

Branch Offices: Dallas • Chicago

Announcing the NEW

ENJAY LABORATORIES

—another milestone of service to industry



The first section of the new Enjay Laboratories, at Linden, New Jersey, houses 12 laboratories and 14 offices in this modern cement-brick structure.

This month the Enjay Company announces the opening of the new million dollar Enjay Laboratories. Here, with the newest and best facilities available, the Enjay Company is better equipped than ever before to serve its customers.

Enjay has been a pioneer and leading supplier of petroleum chemicals to industry for 35 years. Enjay and its associated companies were the first to make available alcohol and other additives from petroleum, first to make iso-octyl and other higher alcohols by the oxo process. BUTYL rubber and the process for making it were created in Esso Research and Engineering Laboratories.

The new Enjay Laboratories are dedicated to making Enjay products work for industry. The well-equipped staff is ready to give expert technical assistance in the use of ENJAY BUTYL and other polymers, chemical raw materials, PARAMINS for improving petroleum products, alcohols and oxygenated solvents.

You are cordially invited to contact the Enjay Company or its representatives for information, supplies of these products and the services of the Enjay Laboratories.

ENJAY

35 successful years of leadership in serving industry

ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y. Other Offices: Akron•Boston•Chicago•Tulsa

For more data on advertised products, use Readers' Service Cards, last page.

customer reduces
estimate of job cost
$24,000
by switch to
WELDOLETS

An oil piping
contract recently
was reduced by $24,000
by changing specifications to
WELDOLET welding fittings.

Comparable savings are possible
on almost every piping contract.
It will pay you to examine this
positive means of reducing your
piping costs. Write us for details.

WELDING FITTINGS DIVISION

BONNEY FORGE & TOOL WORKS

721 MEADOW ST., ALLENTOWN, PENNA.

Earnings Bolstered by Worldwide Activity

Continued from Page 138

$1,325,347,553 that they earned in 1953.

In contrast, 31 other U. S. oil companies, having more limited, if any, foreign operations, reported combined net income of $941,176,590 in 1954, a decrease of 3.3 percent from the $973,086,676 that they earned in 1953.

The five large companies, incidentally, earned almost 50 percent more in 1954 than all the other 31 companies together.

The five world-scope companies were the top five in earnings, and together they accounted for practically 60 percent of the total earnings of the 36 companies included in the tabulation.

The five large concerns were sufficiently predominant in the earnings record to swing the industry into the position of showing an over all increase of 1.4 percent in profits for 1954 over 1953, despite the aggregate decrease for the 31 other companies.

Numerically, there was exactly the same number of companies showing increases and decreases. Of the 36 companies, 18 showed higher earnings in 1954 than in 1953 and 18 registered decreases in profits.

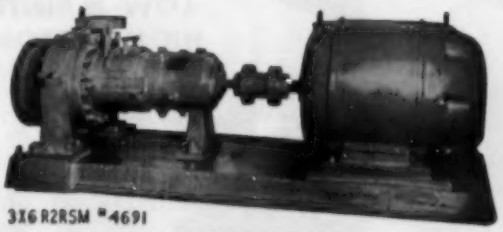
Foreign Consumption Gains

The relatively better earning performance of the five largest companies reflected especially the fact that petroleum consumption increased more outside the U. S. than in the U. S. in 1954, and production of other countries increased while that of the U. S. showed a decrease. In reporting on its operations in 1954, Standard Oil Company (New Jersey), world's largest oil company, stated that foreign demand for oil products last year rose 11 percent, while U. S. demand was up only about 2 percent.

U. S. Bureau of Mines statistics show that total demand for all oils was 1.3 percent higher in 1954 than in 1953, with domestic use up 1.9 percent and exports down. The bureau also reported that the total domestic production of crude oil and natural gas liquids combined was 1.2 percent less in 1954 than in 1953, with crude out-

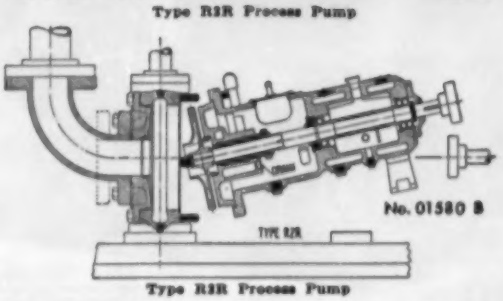
DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



316 R2RSM #4691

Type R3R Process Pump



Type R3R Process Pump

DISASSEMBLY: The Type R3R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

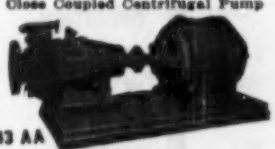
OPERATING RANGE: Type R3R. Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute.
Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL and RECIPROCATING PUMPS

4048M
Close Coupled Centrifugal Pump

3510
Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids



4043 AA
Pedestal Mounted Centrifugal Pump

3833
Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump

4728
Double Pedestal Bearing Centrifugal Pump

3556
Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS IND.

323 W TENTH ST.

Branch Offices: NEW YORK, N. Y., HOUSTON, TEXAS

Representatives in Principal Cities

For more data on advertised products, use Readers' Service Cards, last page.

"K" type pump handling concentrated mixture containing high proportion of free sulfuric acid.

HILLS-McCANNA "K" type HYDRAULIC metering and proportioning pump

In the Hills-McCanna "K" pump, a unique, in-line, direct acting hydraulic drive system eliminates familiar pump problems of exposed linkage, linkage lubrication, atmospheric effects . . . linkage and drive misalignments. Maximum reliability and performance with a minimum of maintenance is assured.

But there's more . . .

A wide choice in corrosion, wear and abrasion-resistant liquid ends gives the "K" pump a broad application range . . . it will meter and proportion virtually any fluid.

If you refine, process, handle or just *pump* problem fluids, it will pay you to remember that the Hills-McCanna "K" pump is available in one and two feed units in capacities up to 726 gph per feed.

Write for Bulletin KP54, HILLS-McCANNA CO., 2441 W. Nelson St., Chicago 18, Illinois.

COMPLETELY ENCLOSED

ADJUSTABLE WHILE IN OPERATION

OPERATES IN OIL

BUILT-IN PRESSURE RELIEF

HILLS-McCANNA

metering and proportioning pumps

Also Manufacturers of:
SAUNDERS TYPE DIAPHRAGM VALVES
FORCE FEED LUBRICATORS • MAGNESIUM ALLOY SAND CASTINGS

As Management Sees It . . .

put off 1.7 percent and production of natural gas liquids up 4.0 percent. Some of the crude processed was withdrawn from storage.

Why the decline? Numerous companies in their annual reports attributed the decline in their earnings in 1954 to decreases in crude production under lower allowables in Texas and elsewhere. Some of the companies complained that imports were supplanting domestic production. Bureau of Mines figures show that total petroleum imports into the U. S. in 1954 were 1.7 percent above 1953, with crude oil receipts up 1.3 percent and refined product imports up 2.4 percent.

In discussing its 1954 results, Standard of New Jersey stated that earnings from operations in the U. S. accounted for 23 percent of Jersey's consolidated net income; 55 percent came from the rest of the Western Hemisphere; and 22 percent from the Eastern Hemisphere.

Outlook for 1955. At this time it is indicated that U. S. oil companies in

VICTOR alloy Studs and Bolts have met the exacting standards of the oil industry for more than 30 years. Victor is accustomed to meeting your requirements of quality, price and delivery. Try VICTOR next time you need any fastening.

Write for the new, easy to use VICTOR catalog.

VICTOR PRODUCTS CORP.
2635 W. BELMONT AVE. • CHICAGO 18, ILL.

For more data on advertised products, use Readers' Service Cards, last page.

Another opportunity to boost production
—Number 5 of a series.

Better By 1,860,000 BTU'S

—Better Buy *Wolverine Trufin**

CAPACITY
With Plain Tube 3,960,000 BTU's / hr.
With Trufin* 5,820,000 BTU's / hr.
Capacity up 1,860,000 BTU's / hr.
Using the Same Heat Exchanger

Here's how refinery engineers in a major petrochemical plant stepped up hydrocarbon production. Their problem: insufficient heat exchanger capacity. Their solution: retube with Trufin Type S/T—the industry's only integral finned tube.

Capacity sky-rocketed from 3,960,000 to 5,820,000 BTU's per hour—a net gain of 1,860,000 valuable BTU's! Production soared accordingly.

Trufin Type S/T is a one-piece, extended surface tube designed expressly for shell and tube heat exchangers and condensers. Specifically, Trufin condenser tubing with a ¾" nominal fin diameter has an external to internal surface ratio of 3½ to 1; it has approximately 2½ times the outside surface of the plain tube with ¾" outside diameter it is designed to replace.

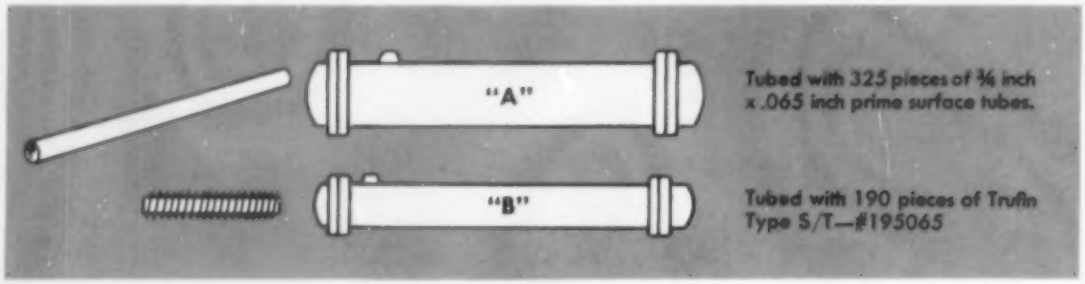
It's easy to retube with Trufin because it is mechanically interchangeable with prime surface tube—can be rolled or brazed into headers by conventional means.

Trufin is a better buy: It's available in a wide range of sizes in copper, copper-base alloys, aluminum, electric-welded steel and bi-metal. Send prints for a quote—today. You'll save! And write for copy of Wolverine's Opportunity Book.

*REGISTERED U. S. PATENT OFFICE

WOLVERINE TUBE
DIVISION OF CALUMET & HECLA, INC.
Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

Let's talk about Condensers



Tubed with 325 pieces of ¾ inch x .065 inch prime surface tubes.

Tubed with 190 pieces of Trufin Type S/T—#195065

Take a look at the sketches of the two shell and tube condensers above. One is substantially larger than the other—*but both handle the same heat load!*

That's important because it represents vital savings in metal—both in the size of the condenser shell and in the number of tubes required.

Additional savings in heat exchanger maintenance, too. After all there are 135 less tubes. Units get back on stream faster!

Assuming that Condenser "A" is a four-pass unit and Condenser "B" a two-pass unit, it is interesting to note that "B" (tubed with Trufin Type S/T) has the least tube side pressure drop.

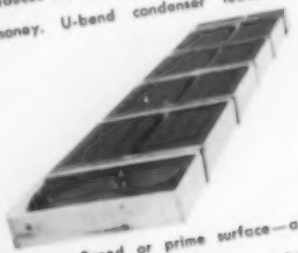
Use of Trufin (all factors such as alloys, water conditions, temperatures and unit design taken into consideration) with an increase in tube side velocity gives a greater boost in heat transfer capacities. This provides the equivalent of additional equipment without additional cost. It adds up to more BTU's per dollar.

Technical discussions on Trufin applications and advantages can be found in Wolverine's Opportunity Book. Write for a copy today! WOLVERINE TUBE, 1437 Central Avenue, Detroit 9, Michigan.

Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ontario.

Save Even More!

This new Wolverine idea cuts time, reduces storage problems, and saves money. U-bend condenser tubes—



either finned or prime surface—are arranged in a disposable box-type pallet in the exact order you specify. All you have to do is feed them directly from pallet to unit.

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Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

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As Management Sees It . . .

the aggregate will show a moderate increase in earnings in 1955 as compared with 1954, with both large and smaller companies generally showing gains. The world-wide operators probably will benefit again from an increase of 8 or 9 percent in demand for oil outside the U. S. and may again show relatively better results than the industry as a whole. Both those large concerns and other companies will have the advantage of expected increases in demands upon the U. S. industry, amounting to about 3 percent on total domestic and export requirements of oils and 4 percent in domestic consumption. Oil inventories are reasonable, and prices of crude and products promise to hold at established levels.

Whose Oyster . . . ?

The articles in "As Management Sees It," popular PETROLEUM REFINER department, is whose oyster? Read the discussion on page 5.

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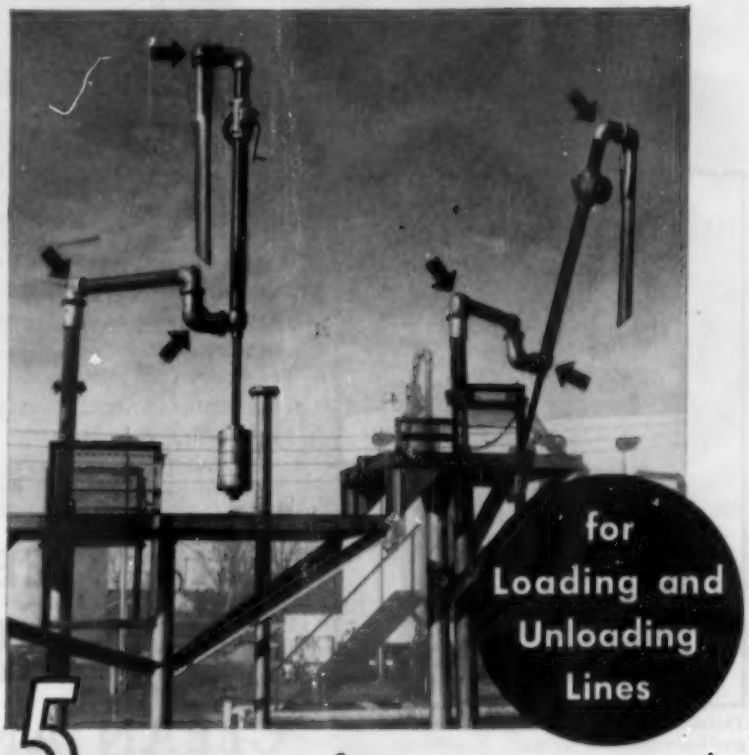
BARCO Swing Joints and Assemblies



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1. **BALL BEARING AND O-RING EQUIPPED**—Designed specifically for handling gasoline, oil, lube oil, LP gas, petro-chemicals, and other petroleum products.
2. **LARGE BEARING SURFACE**—Barco's bearing design provides adequate support for lengths of piping. Minimizes bearing pressures and wear.
3. **CONTROLLED TORQUE**—No annoying, uncontrolled swinging of lines. They swing easily but stay put.
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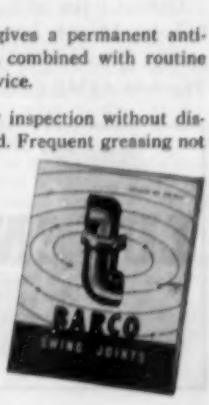
The Barco line is complete with single swing, double swing, and counter-balance styles and assemblies to meet every need. Sizes 1", 1½", 2", 2½", 3", 4". All steel or malleable iron. Send for latest Catalog No. 400 containing engineering and ordering information. *Worldwide sales and service.*



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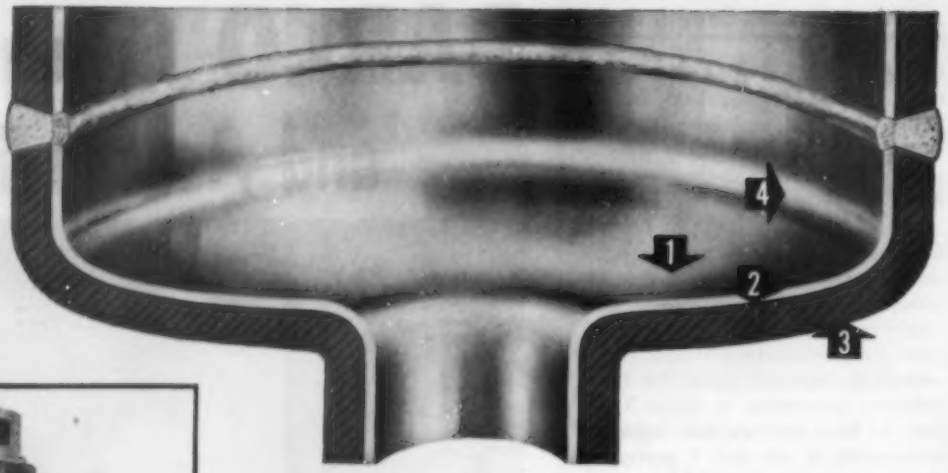
For more data on advertised products, use Readers' Service Cards, last page.



This nickel-clad steel agitator kettle handles chlorinated hydrocarbons under severe operating conditions.

1. **ECONOMY**—High-alloy layer—usually 10% or 20% of total plate thickness—assures corrosion and abrasion resistance, long equipment life.
2. **DESIGN FREEDOM**—Integral bond allows design and fabrication of shapes to meet process and space needs.
3. **STRUCTURAL STABILITY**—Carbon or alloy steel backing gives required strength and rigidity at lower cost.
4. **LESS MAINTENANCE**—Smooth, hard surfaces, rounded corners and sloping bottoms mean easy cleaning and draining.

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In those parts of your process where unscheduled shutdowns mean a big operating loss, clad steel equipment's smoother, more uniform surfaces mean easier cleaning and drainage to help reduce over-all corrosion rates. Preventive maintenance is simplified, for clad tanks and vessels are easier to inspect than lined equipment. The layer of high-alloy cladding gives all the protection and corrosion resistance of solid alloy material, does not permit seepage or crevice corrosion.

Sixteen types of Lukens' clad steel—stainless, nickel, Inconel, Monel, copper—give you these advantages at *savings up to 50%* in material costs over solid high alloys. The API-ASME Code permits full gage consideration for design purposes because cladding and backing are bonded over their entire surface.

Clad steel equipment assures long life with minimum maintenance, economy of field erection, resistance to thermal shock and easy modification as processes change. Take advantage of these benefits, check with *qualified* equipment builders. Working with your engineers and consultants, they can help you get more for your equipment dollar. We offer the widest selection of clad steels available anywhere and we can help in the selection of the type of clad steel that best suits your needs. If you would like more information, consult one of your equipment builders or write Manager, Marketing Service, 751 Lukens Building, Lukens Steel Co., Coatesville, Penna.

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What's Happening . . .

. . . in the Industry

Refinery Runs Cut To Adjust for Seasons

Refinery runs were cut back sharply during April, reflecting the announced intentions of many refiners to adjust for seasonal changes in demand for petroleum products.

Domestic demand for products during the second quarter of 1954 was about 1 million barrels a day lower than during the preceding three months. Related to the 8.8-million-barrel-a-day demand during the first quarter of 1955, the anticipated reduction in demand is equivalent to 11 percent.

Mid-Continent Petroleum Corporation cut crude runs at its Tulsa refinery by this amount for the latter part of April. The reduction was in excess of 6000 barrels a day.

Continental Oil Company reduced its runs slightly beyond this figure, cutting production by 11.3 percent, as compared to the level for the first quarter.

Pan-Am Southern achieved an 8-percent cut back by closing the Vivian, La., refinery of its affiliate, Stanolind Oil & Gas Company. Some usable equipment is being dismantled for shipment to other refineries and terminal points and the balance is being junked.

Standard Oil Company (Indiana) reduced its runs to the stills 8 percent from the level of the preceding two months, as did Humble Oil & Refining Company, which reduced April runs by 20,000 barrels a day from the February and March levels. American Oil Company cut back by 8.3 percent. Sinclair Oil Corporation and other companies made similar reductions.

Underground LP-Gas Stocks Show Decline in February

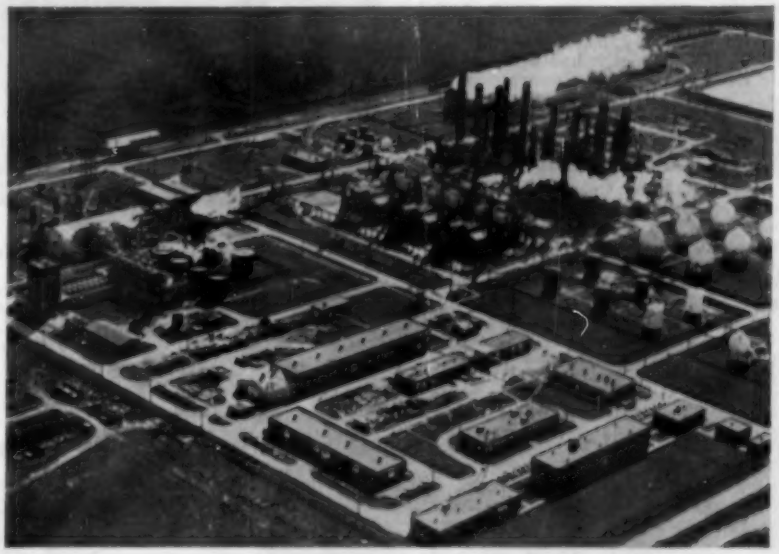
Underground stocks of LP gases totaled 117 million gallons on February 28. According to figures released by the U. S. Bureau of Mines this represents a decline of 41 million gallons.

Of the total, 95 million gallons were concentrated in Mississippi, Louisiana, Texas and New Mexico, with the rest distributed through New York, Michigan, Illinois, Kansas, Oklahoma and Montana.

Underground stocks of propane totaled 65 million gallons, a decline of 49 million. Butane stocks totaled 43 million gallons, or 10 million more than at the end of January. Butane-propane mixtures amounted to 9 million gallons, a decline of 2 million.

Government Studies Synthesis by Atoms

Scientists with the U. S. Bureau of Mines are studying possibilities for using an atomic reactor to make cheap synthetic gas. The bureau is investigating an atomic reactor capable of producing temperatures between 2000 and 3000 F. Pulverized coal and steam would be run through the unit to produce synthesis gas.



FMC Buys Houston Butadiene Plant—

A government-owned butadiene plant at Houston has been acquired by Food Machinery & Chemical Company. The plant, the second largest of seven butadiene plants sold by the Rubber Producing Facilities Disposal Commission, was built in 1943 at a cost of $31 million. The 90,000-ton-a-year plant was operated for the government by Sinclair Rubber Corporation. The facilities are to be owned and operated by a new corporation held jointly by FMC and Tennessee Gas Transmission Company.

Government Completes Sale of Synthetic-Rubber Industry Plants

Private companies went into operation in April as owners of synthetic-rubber plants formerly held as a government-owned monopoly. With the plants, went the government's inventory of finished rubber, to serve as a ready supply for consumption in May.

The first transfer of a plant to private ownership took place in Baton Rouge, La., where Esso Standard Oil Company paid $16 million for the butyl rubber units it had operated for the government since 1942. The plant was built for an annual output of 47,000 tons.

Other Baton Rouge facilities, a synthetic-rubber plant and a petroleum-butadiene plant, went to Copolymer Corporation, which had been operating both units.

In the Houston area, four plants were taken over by private companies for a total cost of almost $65 million. A fifth plant in the area, operated by General Tire & Rubber Company at Baytown, will be sold later.

- Humble Oil & Refining Company purchased the butyl and butadiene plants it had been operating at Baytown. The company paid approximately $29 million for the two units and an inventory worth about $3 million.
- Goodyear Synthetic Rubber Corporation bought the Pasadena copolymer plant for $11,889,000. The company, which had been operating the Houston area plant, also acquired a plant in Akron, Ohio.
- Food Machinery & Chemical Corporation acquired the butadiene plant in Houston for approximately $24 million. The 90,000-ton-a-year plant, formerly operated by Sinclair Rubber Corporation, will be run by a corporation to be owned equally with Tennessee Gas Transmission Company.

Shell Chemical Corporation is shifting personnel for a combined butadiene-styrene-copolymer operation in the Los Angeles area (See What's Happening to Men in the Industry). The company purchased the copolymer plant operated by Midland Rubber Corporation; a styrene plant run by The Dow Chemical Company, and a petroleum butadiene plant it had been operating.

In Louisville, Ky., the government leased its alcohol butadiene plant for three years to Publicker Industries, Inc., at a lease rate of $6 for every ton produced. The contract calls for a minimum guaranteed rental of $1,000 a month.

Another Louisville plant, a copolymer

What's Happening. . .

unit, was purchased by American Synthetic Rubber Corporation. This is the same company which has been operating the plant.

The Firestone Tire & Rubber Company has launched a $1.2-million expansion of the two synthetic-rubber plants it purchased from the government. The company paid $13,136,612 for the Lake Charles, La., plant it had been operating at Lake Charles, La. Construction there will increase the plant's capacity by 13 percent. At the Akron plant, which Firestone bought for $2,845,205, equipment is being converted to increase the output of cold rubber.

Another Lake Charles plant passing into private hands is a butadiene unit bought by Petroleum Chemicals, Inc., a subsidiary of Continental Oil Company and Cities Service Rubber Corporation. Cities Service had been operating the plant.

Phillips Chemical Company has made changes in its personnel, following the purchase of butadiene and copolymer plants at Borger, Texas. (See What's Happening to Men in the Industry.) Plains Company had been running the plants for the government.

Goodrich-Gulf Chemicals, Inc., and Texas-U. S. Chemical Company bought three plants at Port Neches, Texas. The former company, a subsidiary of Gulf Oil Corporation and The B. F. Goodrich Company, purchased a copolymer plant and half interest in a butadiene unit. The Texas Company and U. S. Rubber Corporation share interest in the latter company, which bought another copolymer plant and the other half interest in the butadiene plant. Goodrich-Gulf made a cash payment of $41,418,618; Texas-U. S. paid $40,176,454.

Koppers Company, Inc., bought the government's alcohol butadiene plant at Kobuta, Pa. The facilities there have been idle since 1953.

A synthetic-rubber plant and a dodecyl mercaptan plant at Naugatuck, Conn., were bought by U. S. Rubber Company. Standard Oil Company of California bought a petroleum butadiene unit at El Segundo, Calif.

New WPRA Board Meets—

Directors of the Western Petroleum Refiners Association are shown at their first session following the election at the 43rd annual meeting in San Antonio, Texas. Seated, left to right, are: F. W. McCurry, Walter Famariss, Jr., L. D. Mann, Bruce K. Brown, Don O'Hara, Roland V. Rodman, Paul D. Williams, Reid Brazell, Fayette B. Dow, H. T. Ashton, F. L. Martin, L. B. Simmons, J. W. Warner, and Rex S. Blazer. Standing, left to right: C. C. Tate, Dr. F. J. Sanders, T. E. Fitzgerald, R. L. Tollett, J. B. Smith, John S. Wertz, H. J. Kennedy, J. W. Vaiden, L. L. Leabo, Brown L. Meece, Everett Wells, J. P. Langfitt, Bruce McCully.

API Endorses Plans To Improve Highways

Directors of the American Petroleum Institute, have emphasized their continued support of sound programs for more and better highways.

Frank M. Porter, API president, stated "that no industry has a better understanding of the needs, or more of a stake in the improvement of our road system. The petroleum industry is united in its desire to further highway improvement at a pace equal to the needs of traffic and of the national economy."

Porter pointed out, however, "that the enthusiasm for the objective of an expanding highway program must not blind us to the fact that the costs are high and programs must be soundly financed and carried out with a minimum of inefficiency and waste."

He continued, "From our study, we have concluded that continuing to vest the major responsibility for highway improvement in the state governments offers the surest, most equitable and most efficient means of achieving the desired goal of adequate and continuing highway development at reasonable cost."

U. S. Octane Ratings Continue to Climb

Premium gasoline octane ratings have increased in 45 of the 51 cities covered in Du Pont Company's quarterly motor gasoline survey. Regular-grade gasoline ratings were up in 38 cities.

According to another survey, conducted by Ethyl Corporation, gasolines on sale at service stations in April rose to a nationwide weighted average of 95.2 octane number for premium and 87.7 for regular.

These figures show premium ratings 0.3 octane number higher than in March and 1.9 higher than a year earlier. Regular gasoline was up 0.2 octane number over March and 1.4 over April 1954.

Du Pont reported Houston had the highest octane rating for premium with 96.9. Other cities with average premuim

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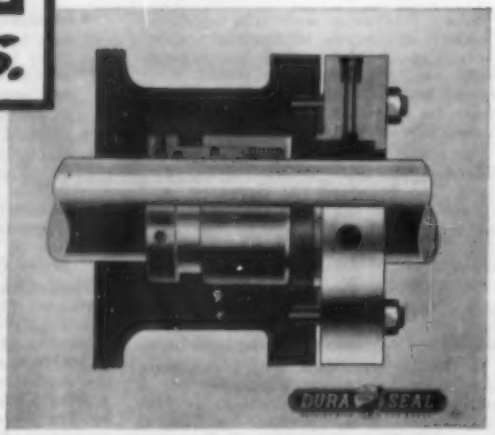
A Single Balanced Mechanical Seal for Light Hydrocarbons at High Pressures...

Now — perfect sealing for pumps handling light hydrocarbons up to 600 lb. pressures. Can be installed on your present equipment — no special sleeves or machining required.



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KALAMAZOO MICHIGAN

IT GRABS 360 POUNDS OF WATER

FROM INSTRUMENT AIR EVERY DAY!

IT'S A PRITCHARD HYDRYER*—the packaged dryer that has proved itself in so many refinery operations

This particular HYDRYER is at Union Oil Company of California's Wilmington plant. It is capable of removing 360 pounds of water from instrument air every 24 hours. It dries 600 SCFM of instrument air at 50-60 psig and 90°F.

A HYDRYER can eliminate your moisture problems, too, and cut out costly plant and equipment shutdowns due to moisture and ice. A HYDRYER protects instruments and controls. It reduces corrosion, line losses, flow stoppages.

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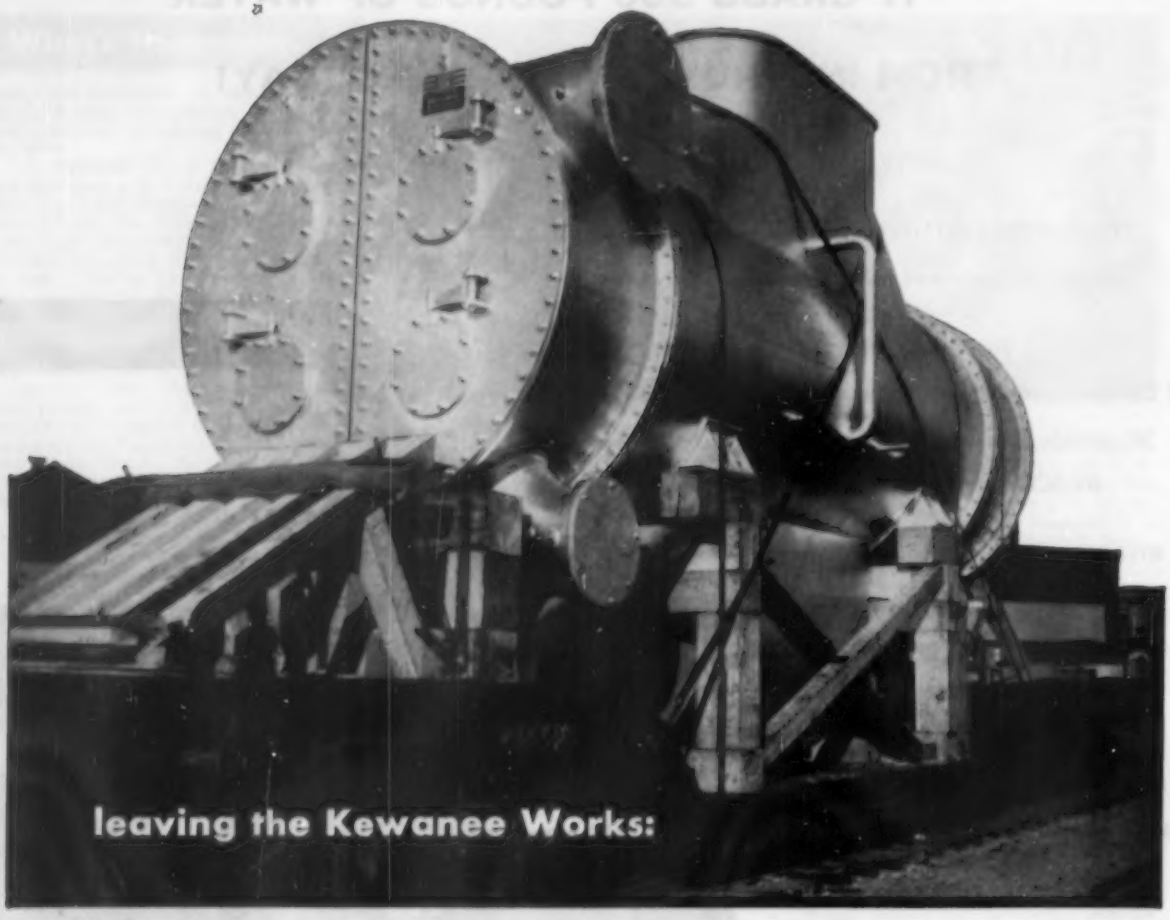

ROSS SURFACE CONDENSERS TRAVEL TO ALL CORNERS OF THE WORLD

Leaving the Kewanee, Ill. plant, this Ross Surface Condenser is one of a pair bound for New Mexico. It's a relatively short trip compared to the distances that many Ross units have traveled to reach countries such as Australia, Brazil, Iran, Aruba, Sumatra . . . mentioning but a few. Their efficiency and dependability have been proved in remote and isolated locations all over the world.

The reason Ross Surface Condensers are widely preferred, for installations both in the U. S. and foreign countries, can be expressed in two words: *advanced engineering* . . . engineering that introduced the first all welded steel surface condenser at Parr Shoals, S. C. in 1929 and pioneered numerous other developments, including Balanced Flow and divided tube bank design.

It's only logical then, that Kewanee-Ross is best qualified to meet *your* surface condenser requirements, too. Consultation with Kewanee-Ross engineers will leave you assured of this.

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What's Happening . . .

ratings of 96 or better were Baltimore, Boston, Charlotte, Corpus Christi, Dallas, Fort Worth, Jacksonville, Little Rock, Nashville, New Orleans, metropolitan New York, Pittsburgh and Philadelphia.

In regular grades, Boston took the lead with an average 90.4 rating, over Philadelphia, the only other city with a regular rating above 90 and holder of the top position in the past two surveys.

CHEMICALS WANTED

The National Registry of Rare Chemicals, Armour Research Foundation of Illinois Institute of Technology, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

Coronene
2-(beta-Hydroxyethylamino) phenol sulfate
2,6-Dimethylol-1,4-dioxane
2,5-Dimethylol-1,4-dioxane
Phenyldimethylphosphine
Cyclohexylcarboxaldehyde
para-Trifluoromethylphenylacetic acid
1-(4-Chloromercuriphenylazo)2-naphthol (Sulfhydryl reagent)
3-Mercaptopropionic acid
Catechol methylene ether
Sodium sulforicinoleate
tris(para-Nitrophenyl)methyl chloride
Magnesium lauryl silicate
3-Keto butanol
Methylene fluoroiodide
2,2-Dimethylol-3-butanone
Cyclopentanepropionic acid
Diphenyldecapentene
Dibromofumaric acid
N-Ethyltetrahydroquinoline

Five Professors Form Pittsburgh Consulting Firm

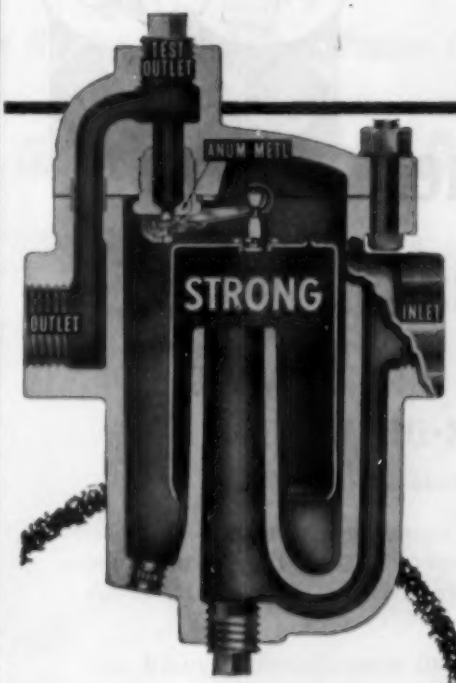
Five Carnegie Tech professors have combined their consulting practices to form Associated Chemical Engineers, a consulting partnership in Pittsburgh. The partners, all members of the school's Department of Chemical Engineering, are D. H. Archer, R. B. Beckman, L. N. Canjar, R. R. Rothfus and H. L. Toor. The new firm will serve petroleum, chemical and allied process industries in the Tri-State area.

Improved Techniques Cut Shale Oil Costs

The cost of producing crude oil from shale may have dropped 25 percent since the National Petroleum Council made its cost estimates in 1951. According to a Department of Interior report, the cost of crude production would be reduced by that amount if preliminary Bureau of Mines estimates were substituted for the council's figures which ran $2 a barrel.

The department's annual report on synthetic liquid fuels pointed out developments in mining techniques and experimental-scale developments of the gas-combustion retorting process. It stated, how-

HYDRO-FLEX — we engineered this new steam trap for YOU!



☐ Install Strong Hydro-Flex steam traps with assured confidence. This completely new line of low, medium, and high pressure steam traps will operate equally well on light and heavy condensate loads.

Hydro-Flex offers these outstanding features and more:

- greater discharge capacity and efficient operation under *all* conditions
- dual fulcrum arrangement that snaps the leak-free valve wide open to give unrestricted condensate flow
- all working parts and deep-drawn bucket of durable stainless steel.
- rugged construction features assure long trouble-free service.

For complete information, contact your local Strong Distributor and write for new Bulletin No. SS-40A.

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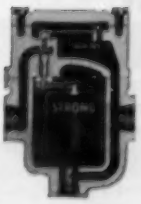
STRONG®
HYDRO-FLEX
STEAM TRAPS
high efficiency under all condensate loads

Available from over 200 industrial distributors in the United States, Canada and Foreign Countries.

BOTTOM INLET SERIES
Hydro-flex traps with bottom inlet have the same high qualities and features as horizontal types.

PRESSURE REGULATING VALVES
3 types available for wide range application . . . to meet pressure and capacity requirements.



BLAST TRAPS
Thermal types for quick air and condensate removal during rapid heating up.

STRONG STRAINERS
Offer maximum protection from dirt, scale or sediment. Available in semi steel, cast steel and bronze.

For more data on advertised products, use Readers' Service Cards, last page.

One-half actual size

men and machines move safely over • LOW-COST • LONG-LASTING A.W. SUPER-DIAMOND

Rolled Steel Floor Plate

Where safety and economy are "musts"—no other floor plate can match SUPER-DIAMOND's rolled steel ruggedness and easy maintenance for so low a cost.

At every step 40 steel diamonds guard constantly against skids and slips. This non-directional pattern floor plate fabricates easily . . . can be installed overnight . . . gives years of dependable safety under the heaviest industrial loads.

Mail coupon for full details on this low-cost, long-lasting rolled steel floor plate.

A.W. SUPER-DIAMOND ROLLED STEEL FLOOR PLATE

"The diamond in the rough . . . a gem of a flooring."

ALAN WOOD STEEL COMPANY
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Other products: A.W. ALGRIP Abrasive Rolled Steel Floor Plate—Plates—Sheets—Strip—(Alloy and Special Grades)

For plants where oil, water and grease raise special problems of slipping accidents, we suggest a check on the special qualities of A.W. ALGRIP . . . the world's only abrasive rolled steel flooring.

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What's Happening. . .

ever, that additional development work is required to verify the preliminary economic study being made by the Bureau of Mines.

"As development continues and as workable commercial-scale units can be visualized, a detailed design and cost estimate will be made to determine the economics of producing crude shale oil using improved methods and the gas-combustion retorting process," the report stated.

The report also revealed that preliminary investigations indicate that the maximum size an oil shale industry might reach would be between one and two million barrels a day. The principal limiting factor would be the availability of water.

IPAA Terms Outlook Good for Oil in 1955

The demand outlook for oil is improved, according to a report by the Independent Petroleum Association of America. The report, prepared by the association's Supply & Demand committee, states, however, that there is still a need for substantial reductions in domestic output.

The committee estimated total demand for oil products this year would average 8,474,000 barrels a day. This represents a 4.5-percent gain over 1954, and runs 104,000 barrels a day higher than had been forecast last October.

Crude production for 1955 was estimated at a daily average of 6,635,000 barrels, an increase of 4.5 percent over last year. The committee predicted crude imports would increase 12 percent, and refined-products imports would stand 8.6 percent above the level for 1954.

Demand for oil products hit a record 9,115,000 barrels a day during the first quarter of 1955. This is 6.1 percent higher than the first quarter a year ago.

German Holding Company To Handle Chemical Stock

West German Liquidation committee of the former I. G. Farben chemical combine has formed Chemie Verwaltungs, A. G., as a holding company for Chemische Werke Huels, A. G., with a capital of 81,600,000 marks (about $19.2 million).

Huels, formerly part of I. G. Farben, is now West Germany's sole producer of synthetic rubber (buna). Shares of the holding company will not be distributed, but will be placed in trust until all claims against the former I. G. Farben organization have been settled.

Sohio to Begin Using Data-Processing Machine

The Standard Oil Company of Ohio will place in operation a new-type, high-speed data processing machine at its home office in Cleveland. Utilizing a 20,000-digit "memory," the equipment is expected to work equally as well in solving technical problems and handling routine office work.

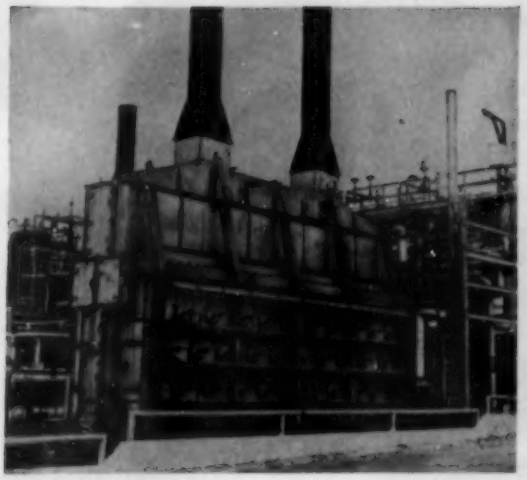
The machine is reported as able to process 100 analyses of sample of hydrocarbon gas from company refineries in 18 minutes. With conventional punch-card equipment,

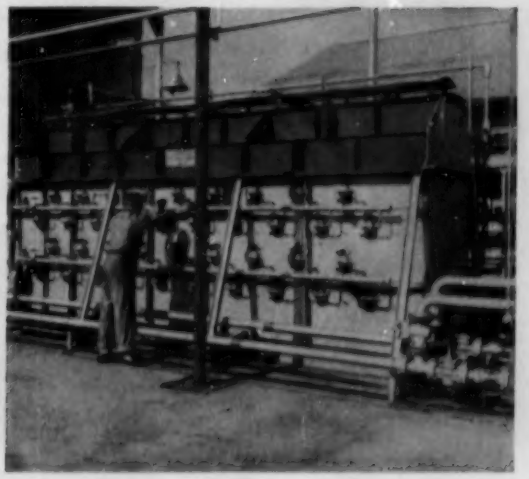
For more data on advertised products, use Readers' Service Cards, last page.

35 MILLION BTU's...or more
1½ million...or less

The Same Uniform Heating...Flexibility...Precise Control...from

SELAS *Gradiation* HEATERS





Size is no limitation to the advantages of Selas radiant heaters and Zone Control.
Whether processing petroleum or chemicals . . . for pilot plant or volume production . . .
Selas Gradiation heaters offer the following desirable features:

- Compact heating units with multiple coils and absolute temperature control in a single radiant chamber.
- Flexibility in shaping the heating curve.
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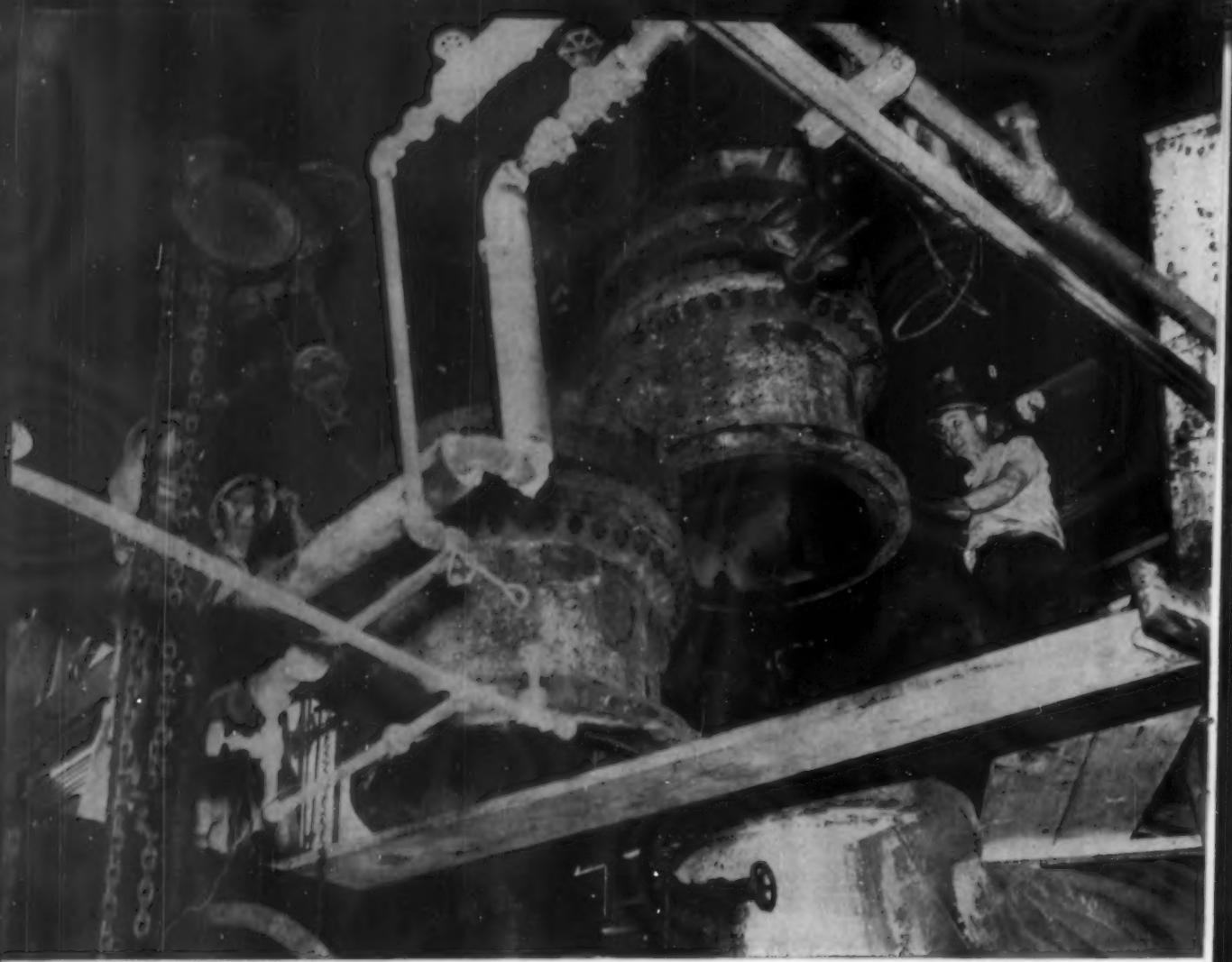
- Prolonged tube life—lower maximum tube wall temperature, through more uniform circumferential heat distribution, minimizes corrosion rate.

Selas Gradiation heating offers new possibilities in every petroleum or chemical plant where heat processing is a precise operation.
Send for informative bulletin on selection of heaters for petroleum and chemical processing.

SELAS FLUID PROCESSING

CORPORATION OF AMERICA • PHILADELPHIA 34, PA.

For more data on advertised products, use Readers' Service Cards, last page.



TURNAROUNDS BY PROCON

During the first quarter of this year, seven petroleum refineries have entrusted Procon with their turnaround projects, knowing that their on-stream operations would be resumed after just a short period of down-time. With the rapid completion of this important preventive maintenance work, these refiners were assured of continuous trouble-free operations in the production of high-quality petroleum products.

The outstanding record achieved on these projects is typical of the many services available to refiners when Procon is on the job. It will be to your advantage to plan your next turnaround operation with Procon.

PROCON *Incorporated*

1111 MT. PROSPECT ROAD, DES PLAINES, ILLINOIS

PROCON (CANADA) LIMITED—40 ADVANCE ROAD, TORONTO
PROCON (GREAT BRITAIN) LIMITED—112 STRAND, LONDON

WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES

PROCON®

it now takes the company three days to do the job.

Other technical operations expected to be set up include the rapid processing of refinery operating data. The equipment will help engineers investigate the optimum operating characteristics for refineries and aid in the study of crude oil allocation, transportation and gasoline blending. It also will be used to prepare profitability reports for product planning.

Ceylon to Establish Research Institute

The government of Ceylon is establishing an institution at Colombo to carry on research in developing the country's natural resources and improving its industrial processes and equipment.

Ceylon Institute of Scientific and Industrial Research will receive $210,000 a year from the government for the first five years. A director and another top-level executive will be provided by the U. N. Technical Assistance administration, in conjunction with the World Bank.

Research will be carried out at the institute, to be headquartered at Colombo, for the government and for private business. Confidential services will be available to business interests.

LPG Buses Show Increase

The number of buses fueled by L-P gases totaled 1,951 last year, showing an increase of 17 percent more than in 1953. According to a survey conducted by Liquefied Petroleum Gas Association, buses now on order will bring this total to almost 2100 by the last of the year.

The survey indicated that transit companies drove L-P gas buses more than 76 million miles in 1954, or 16 million more than the previous year. Fleets averaged 3.68 miles a gallon with L-P gas.

Former Lummus Engineer Opens Houston Office

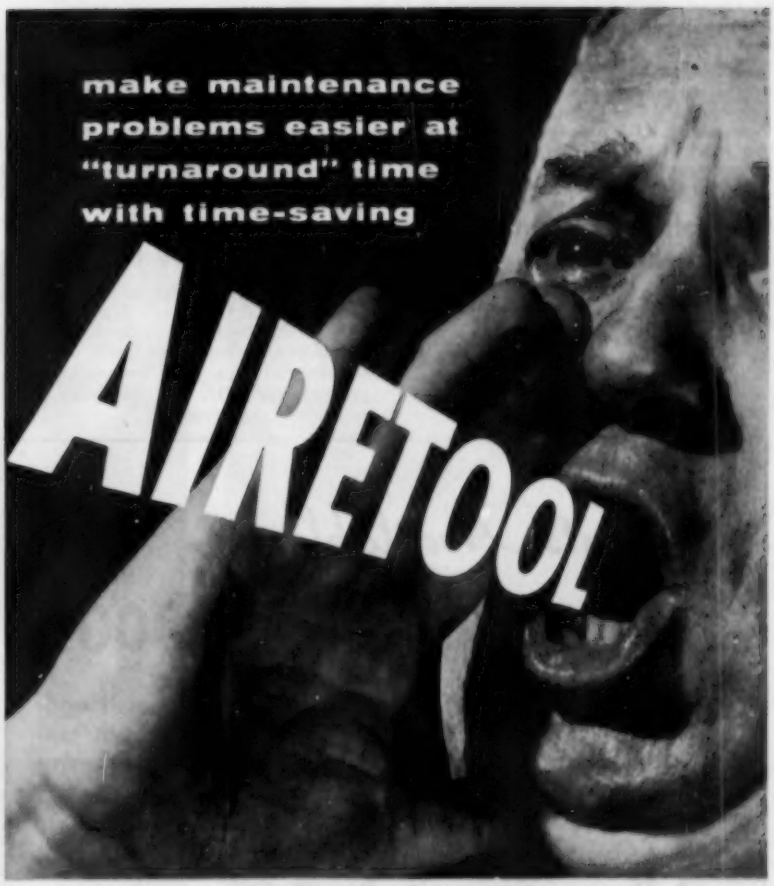
James W. Hayward, until recently with The Lummus Company's engineering office in Houston, has opened an office there as a consulting engineer specializing in process-design work for the petroleum and chemical industries. Before joining Lummus, Hayward taught chemical engineering at Texas A&M College.

West Coast Prices Up

Standard Oil Company of California has raised tank-wagon prices on both its regular and premium gasolines by 0.3 cents a gallon. Standard is the third West Coast company to raise tank prices on automotive fuels.

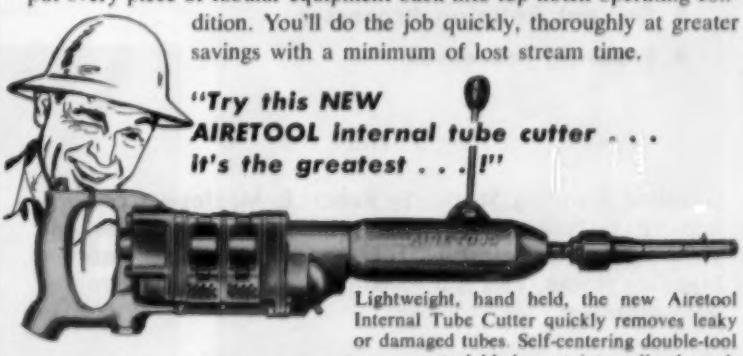
Union Oil Company of California, which has put new gasolines on the market, earlier increased its prices 0.8 cents a gallon on regular grades and 1 cent on premium gasoline. General Petroleum Corporation, which also introduced two new gasolines, boosted its prices on both grades 0.8 cents a gallon.

Standard's new prices bring the com-



tube maintenance equipment

Keep your costs down and plant efficiency way up with Airetool Tube Maintenance Equipment. You can rely on Airetool equipment to remove the replacement and high expenditure headaches of turnarounds and put every piece of tubular equipment back into top-notch operating condition. You'll do the job quickly, thoroughly at greater savings with a minimum of lost stream time.



Lightweight, hand held, the new Airetool Internal Tube Cutter quickly removes leaky or damaged tubes. Self-centering double-tool steel blades cut internally through tube sheets up to 4" thick. Contact your nearest Airetool Representative for a convincing demonstration.

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

Write for literature and full information on Airetool tube maintenance equipment best suited to your needs.

BRANCH OFFICES: New York • Chicago • Philadelphia • Tulsa • Houston • Baton Rouge
Representatives in principal cities of U.S.A., Canada, Mexico, South America, England and Japan
European Plant: Airetool Nederland N. V., Vlaardingen, The Netherlands

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening. . .

pany's tank prices in San Francisco to 26.9 cents a gallon for premium and 24.4 cents for regular. In Los Angeles, Standard prices now run 26.4 cents for premium and 23.9 cents for regular.

Asphalt's Importance Told

The importance of asphalt as a petroleum product was stressed by J. E. Buchanan, president of Asphalt Institute of America, when he addressed the 43rd annual meeting of Western Petroleum Refiners Association recently in San Antonio. Speaking at the association's technical session, Buchanan used the subject, "Asphalt is a Petroleum Product."

German Firm Licensed

The Atlantic Refining Company has licensed Kali Chemie, A. G., a Hanover, Germany firm, to manufacture catalyst for use in the Atlantic Catforming process for making high-octane gasoline. Kali Chemie will install new facilities in its catalyst plant at Nienberg, for production of Atlantic catalysts.

Dow Hits Safety Mark

Employes in several sections of The Dow Chemical Company's Plastics department at Midland, Mich., have reached a 3-million man-hour safety mark without a lost-time accident. They are the first Dow group in either U. S. or Canadian plants to achieve this record.

Reprints Available . . .

1954 PROCESS HANDBOOK

Petroleum REFINER's great September Process Handbook Section, complete with 69 process descriptions and 69 flow diagrams, covering the following comprehensive materials:

- Catalytic Cracking and Reforming Processes
- Thermal Conversion Processes
- Light Hydrocarbon Recovery Processes
- Gas Conversion Processes
- Oil Distillation Processes
- Solvent Refining Processes
- Treating Processes

Plus

Gasoline Blending Stocks, by Robert E. Maples—a comprehensive picture of the susceptibilities, sensitivities and yield-octane relationships for the usual refinery gasoline blending stocks. This is a 16-page article that has attracted wide attention.

ORDER YOUR EXTRA REPRINTS NOW

$1.00 Per Copy

PETROLEUM REFINER Reprint Dept.

P. O. Box 2608 **Houston 1, Texas**

Tulsa Firm Acquires Houston LPG Company

Texas Natural Gasoline Corporation has acquired controlling interest in Ellis Transportation Corporation, Houston wholesale distributor of LP gases.

With the purchase Texas Natural acquires 20 million gallons of underground LPG storage in the Pierce Junction salt dome, near Houston. This storage, together with an underground terminal Texas Natural has developed at Mont Belvieu, Texas, and its underground storage in West Texas, gives the company total facilities for approximately 75 million gallons.

Tide Water Joins Attack On Littered Highways

One thousand renovated 55-gallon metal drums have been donated to the California State Chamber of Commerce for use in an attack on the problems of reducing highway litter. Given by Tide Water Associated Oil Company, the drums will be available to county supervisors to place on county roads as trash receptacles.

Standardization Planned For Centrifugal Pumps

Manufacturers, designers and users of centrifugal pumps have voted to set up standards for pumps. The voting was carried out at a general conference called by the American Standards Association for that purpose.

A national committee will be organized to develop U. S. standards for dimensions which will allow interchangeability of pumps made by different manufacturers. It was estimated that a $6,800,000-a-year savings to the chemical industry alone would be effected by the standardization.

Sohio Cited for Safety

All five refineries of The Standard Oil Company (Ohio) have won awards in the National Safety Council Petroleum Section Safety Contest for 1954. The company's safety performance for the year was the best in its history with only 4.75 disabling injuries for every million man-hours worked.

Receiving special citations were Sohio refining units at Cleveland, Lima, Toledo and Latonia.

Sunray Closes Refinery

Sunray Oil Corporation is dismantling part of the old Rock Island Refining Company plant near Duncan, Okla. Sunray, which formerly leased the refinery, exercised an option to buy it about a year ago.

Units being salvaged by Heat & Power Company, Inc., include a cracking plant, boiler plant and treating units. Sunray will continue to operate the 11,000-barrel-a-day crude unit in conjunction with its nearby refinery.

Moves to New York

Shell Chemical Corporation's Agricultural Chemicals division will move its

What's New at SHELL

A PICTURE ROUND-UP OF SOME ACTIVITIES THAT MADE NEWS OUTSIDE THE PETROLEUM WORLD.

FLEET WORK. In minutes, this Shell-trained oil detective can now diagnose truck engine ills such as faulty oil filters, thermostats and cooling systems—in time to avoid costly damage and major repair bills. Shell's ADC Oilprint analysis, announced for big fleet operators recently, is another example of far-thinking Shell research.

GROUND ATTACK. West of San Antonio, a Shell exploration crew uses the new technique of "pattern shooting" in search for oil. Simultaneous blasts send shock waves deep into the ground, help geologists locate possible oil pockets. "Pattern shooting" is one of the look-ahead techniques constantly employed by Shell crews. These techniques helped Shell bring in many new fields last year.

BUG HATERS. The "most economical, most effective bug-fighters yet devised," says Coronet magazine of aldrin and dieldrin, developed by Shell Chemical Corporation. Tested world-wide over a six-year period, these lethal pesticides will destroy whole armies of man's insect enemies, including sub-surface root grubs which impede the growth of cornstalk, *above, left.* Shell's big investment in research is a solid investment in the future for all of us.

SHELL

For more data on advertised products, use Readers' Service Cards, last page.

many more hours on stream without forced shutdown with NATIONAL AIROIL

OIL-GAS TANDEM COMBUSTION UNITS

Exclusively for vertical firing, the new National Airoil VERTICAL Tandem Block Units retain all the features of our regular horizontal Tandem Units . . . *plus:* special, pre-cast refractory shapes for easier, cost-saving vertical installation and maintenance; secondary air inlet louvres for positive control of vertical flame pattern; and, all steel duplex detaching gear which enables swift, simple vertical burner changeover.

VERTICAL and HORIZONTAL Tandem Units hold air in the combustion zone until fuel and heated air are thoroughly mixed. This means that ignition takes place in a hot zone; the result: high fuel economy through more rapid combustion with a minimum of excess air. NATIONAL AIROIL's patented Tandem Combustion Units allow secondary air to be easily and accurately controlled. By adjusting air control louvres, flame can be shaped to radiate heat uniformly without tube impingement.

The VERTICAL or HORIZONTAL Tandem Unit is always fired with NATIONAL AIROIL Combination Oil and Gas Burners . . . has a high turndown ratio with a steady flame temperature using either fuel oil or gas. With the TANDEM UNITS clean flame, a cold furnace can be brought to full capacity in a short time.

"Many, many more hours on stream, without shutdown" . . . yes, YOU will realize higher profits from YOUR heaters when NATIONAL AIROIL VERTICAL or HORIZONTAL Tandem Units are specified. Our new Bulletin 498 is yours for the asking.

NATIONAL AIROIL BURNER CO., INC.

CHEMICAL-PETROLEUM DIVISION

Main Office & Factory: 1254 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.

Southwestern Division: 2512 South Boulevard, Houston 6, Texas

INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

What's Happening. . .

headquarters to New York from Denver. The division is the sales organization for the company's insecticides.

The transfer of the division, under F. W. Hatch, is expected to give the company a greater access to national marekts and benefit the coordination of marketing activities. Shell's insecticide plant will continue in operation at Denver.

Tide Water Associated Sets Third Safety Record

Tide Water Associated Oil Company's refinery at Avon, Calif., has completed two and a half million man-hours of work without a single disabling injury.

The Avon refinery, which employs 1450 men and women, previously recorded two safety records each of more than one million consecutive man-hours work without a lost time injury. The present or third safety achievement, which started November 1, 1953, and is still continuing, has reached a total of 318 days—two and a half million man hours. This surpasses any previous record for this plant.

Census Report to Include Industrial Use of Water

Bureau of the Census is gathering information on the industrial use of water, for the 1954 Census of Manufacturing. The bureau has estimated that industries using at least 20 million gallons a year have a total annual intake of more than 11 trillion gallons.

Information concerning industrial consumption of water was collected on a limited basis as part of the 1953 Survey of Manufactures, but only industries using 20 million gallons or more were asked to report. The census this year will include all manufacturers.

Chemical Market Award To Go to Enjay Official

The Chemical Market Research Association's Memorial Award this year will go to the first president of the association, James G. Park, vice president and general sales manager of Enjay Company, Inc. The presentation will be one of the features at an annual meeting in New York on May 19.

Park has been associated with Standard Oil Company (New Jersey) for about 25 years. He assisted in Standard's first production of alcohols in 1925, and has been with the subsidiary Enjay Company since it was organized as Standard Alcohol Company in 1932.

Socony-Vacuum Oil Becomes Socony Mobil Oil

Shareholders in Socony-Vacuum Oil Company have voted to change the company's corporate name to Socony Mobil

For more data on advertised products, use Readers' Service Cards, last page.

No Collapse, No Kink, No Crush

It takes a tough hose to load or unload petroleum products from barges or tankers . . . but Ebonite-Skookum Oil Suction and Discharge hoses do the work with a minimum of friction loss.

The heavy gauge tube is made of a special oil-resistant compound. Next to the tube there's a single ply breaker strip, frictioned for strong adhesion between tube and reinforcement. Next come multiple plies of close woven fabric . . . seven to twelve of them . . . surrounding a helix of high tensile, spring steel wire.

This rugged construction eliminates expansion under pressure, collapse under suction, and resists kinking and crushing. This hose stands up under severest duty. Ends are reinforced to prevent bending or breaking at high-pressure, built-in steel nipples. Available in I. D. sizes 3″ to 12″; up to 50-foot lengths.

We also manufacture a complete line of industrial rubber products: belting, hose, packing and moulded rubber for every need. *Through your Quaker and Quaker Pioneer distributor* our research and engineering services are available to help you solve any industrial rubber problem. *Write for name of nearest distributor.*

QUAKER RUBBER CORPORATION
Philadelphia 24, Pennsylvania

HKP

QUAKER PIONEER RUBBER MILLS
San Francisco 7, California

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening. . .

Oil Company. The change, approved by 99 percent of the shares voted, was made to link the company's name more closely with the brand products it sells. The old name was adopted after the 1931 merger of Standard Oil Company of New York (Socony) and the Vacuum Oil Company.

The company will invest about $47 million in domestic refining this year, with more than that amount slated for expenditures in 1956. A large part of the company's projected expenses will be for catalytic-reformer construction.

Institute Opens Laboratory

The Asphalt Institute has dedicated a new laboratory and office building on the campus at the University of Maryland in College Park. The institute is carrying out an expanded research and development program in association with the university's engineering departments.

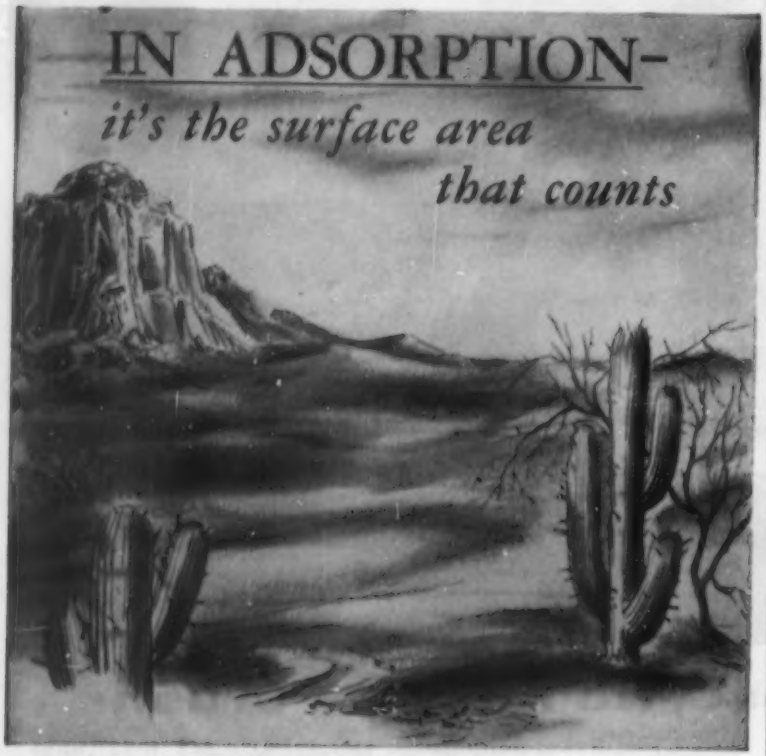
Agency Changes Name

The name of the Interior Department's Oil & Gas division has been changed to the Office of Oil & Gas. The change was made in an effort to standardize titles in the department. No changes were made in personnel or work.

Chemists Group Launches Research in Compounds

Manufacturing Chemists Association has inaugurated research in the properties of chemical compounds. In charge of the project, being taken up at Carnegie Institute of Technology, is Dr. Frederick D. Rossini, head of the chemistry department and in charge of a similar program being carried out for the API.

The purpose of the new project is to investigate the physical and thermodynamic properties of chemical compounds and to prepare a complete set of fundamental data. First to be investigated will be compounds belonging to the halogen, nitrogen and phosphorus families.



Dryer than the desert—extremely porous—the multitudinous particles of Florex Fullers Earth possess an adsorptive capacity unequalled by any other known natural material. Consisting of crystals of colloidal size and fibrous shape, Florex assures maximum effectiveness. Florex is so economical that 50 acres of adsorptive surface costs less than a penny.

Florex is particularly superior in the adsorptive refining, decolorization, clarification and neutralization of mineral, vegetable, and animal oils, fats and waxes and for processes involving the use of highly active clay for sweetening light distillates, dehydrations, desulfurization, and polymerization.

Available in all standard particle sizes, special Florex meshes may also be ordered.

Floridin maintains a modern laboratory with highly specialized equipment for the proper evaluation of your adsorption problems. Technical data, samples, quotations, and the services of staff technicians are available upon request.

FLORIDIN COMPANY

Adsorbents
Desiccants
Diluents

Dept. E Box 998 Tallahassee, Florida

Esso Adopts Record Budget; Slates Plant Improvement

A physical capital budget of $133 million has been adopted by Esso Standard Oil Company. The investment program, the largest in the company's history, will emphasize plant and product improvements, rather than enlarged capacities.

Included in the $100 million slated for expenditures in refinery plant and equipment is $66 million which will go for improving equipment at the company's six refineries. New facilities to be installed are fluid hydroforming, hydrofining and fluid coking units developed by Esso Research & Engineering Company.

Extensions and improvements in the company's pollution-control program will require $3 million. Other refinery projects include the addition of 40 million gallons of tank storage and new harbor and dock facilities. Major improvements are planned for lubricating oil, wax and grease facilities, asphalt manufacturing and refinery utilities.

Socony-Vacuum Affiliate To Produce Lube in Mexico

Compania Commercial Vacuum, S. A., affiliate of Socony-Vacuum Oil Company, has entered an agreement with the government-owned Petroleos Mexicanos to build a $1-million lubricating-oil blending and compounding plant in Mexico. Premex is expected to sign similar agreements with other former importers of lube oil.

The affiliate's plant, which will be built for daily capacity of 500 barrels, will use blending stocks from the government's new lube plant at Salamanca. Mexico has been closed to imported lube oil since the plant was completed.

Cuban University Sets Congress on Petroleum

Cuba will hold its first Congress on Petroleum Oct. 21-23 on the University of the Orient campus in Santiago. Speakers who will appear before the university-sponsored congress include Benjamin T. Brooks, New York consulting engineer; Per K. Frolich, with Standard Oil Development Company; Sidney D. Kirkpatrick, editor of Chemical Engineering; Walter J. Murphy, Brooklyn Polytechnic Institute, and Robert E. Wilson, chairman of Standard Oil Company (Indiana).

Opens Tulsa Offices

Dr. Ronald E. Meyer has opened consulting offices in Tulsa. He plans to specialize in all phases of the petrochemical

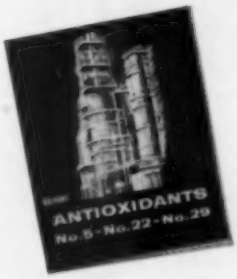
DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

May ★ One of a Series of Interest to the Petroleum Industry ★ 1955

NEW ANTIOXIDANT BOOK NOW AVAILABLE



The complete line of Du Pont Antioxidants – Nos. 5, 22 and 29 – is fully discussed in a new 32-page book.

In addition to the regular application of these antioxidants in motor and aviation fuels, the new book covers the antioxidant sweetening process. It also discusses fully the properties and methods of addition of Du Pont Antioxidants. And there are informative chapters on the general history and function of antioxidants.

The book is profusely illustrated with drawings, colored charts and detailed diagrams. If you would like a copy, just write or mention it to any of our Petroleum Chemicals Division representatives or regional offices.

Refiners can now reduce gasoline treating costs

You can now save about 6% on the cost of Du Pont Gasoline Antioxidant No. 22 . . . by purchasing in tank car lots. In these days of shrinking profit margins, this cost reduction can be an important advantage to you.

Special Cars

To make it convenient for you to take advantage of this saving, Du Pont has available special tank cars with a capacity of 4,000 gallons, or approximately 31,000 pounds of antioxidant. They are equipped with steam coils to facilitate unloading.

Additional Help

Also, the Operations Group of the Du Pont Petroleum Chemicals Division will be glad to help you work out any individual unloading or storage problems which tank car shipments might entail. And any of our representatives or regional offices will be glad to give you further information on these tank car shipments.

A DU PONT SALES SERVICE

To help you take advantage of new lube oil promotion opportunities

Never before have you been able to offer a motor oil with an effective low-duty detergent. But there are now two new polymeric additives that make this possible – Du Pont Lube Oil Additives 564 and 565. And with such an outstanding advantage, they also offer you unique promotion opportunities.

To help you make the most of these opportunities, the Du Pont Petroleum Chemicals Division has prepared a special advertising and promotion kit.

YOU CAN BUILD a complete lube oil promotion plan around the wide variety of suggested copy ideas and other aids contained in this kit.

This kit is stuffed with useful aids and suggestions for promoting your brand of lube oils containing one of these new Du Pont additives. It includes *suggested* copy and layout for newspaper ads, descriptive folders, and a 24-sheet highway poster and window sticker.

Provocative Ads

One of the newspaper ads is designed to focus the attention of the average motorist on the fact that he actually gives his engine harder wear than the typical long-distance trucker. The copy then points out that your brand of motor oil contains a special additive with a detergent action to retard the formation of engine sludge and varnish caused by average stop-and-start driving conditions.

Another suggested ad is built around the common problem of water dilution in the crankcase. It clearly explains how low-duty driving in traffic accentuates this problem . . . and how the polymeric Du Pont additives prevent harmful sludge from forming—even in the presence of water.

To meet your individual promotion requirements, the ads can be readily reduced or increased in size. And the suggested 24-sheet highway poster

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED *Lube Oil Promotion*

can be adapted in size to become a window sticker or station banner.

The copy for these ads and booklets, however, should be rewritten and individually slanted to incorporate the regular competitive features of your own brand of motor oil.

Other Helps

The kit also includes a 12-page technical book and background articles on the development and special properties of these new polymeric lube oil additives. These can be especially helpful to you in tailoring your own promotion material for introducing a new product containing one of these additives.

In addition, there are suggested sales talks to acquaint and excite your dealers with the outstanding advantages of your new product.

SUGGESTIONS for folders, envelope stuffers, a 24-sheet highway poster, window sticker and banner are included on this typical page from the kit.

If you are now using, or are planning on using one of these new Du Pont additives in your lube oils, you will certainly want to take advantage of the special helps contained in this promotion kit. For full details, get in touch with any Du Pont Petroleum Chemicals Division representative or regional office.

DETROIT DISTRICT MANAGER

PAUL H. RICHARD has been named manager of the newly-formed Detroit District of the Du Pont Petroleum Chemicals Division. This district comprises the major portion of the state of Michigan.

An automotive specialist, Mr. Richard will work closely with the automotive industry on combustion and lubrication problems in addition to oil company sales-service contacts.

Joining the Du Pont Company in 1949, he was first assigned to engine research work on fuel scavenging agents. From 1943 to 1947 he was with the National Advisory Committee for Aeronautics, where he worked on fuel evaluation, cooling, compound power plants and turbo-jet fuel systems. Later, with the Lima-Hamilton Corporation, he worked on locomotive diesel engines and free-piston gas turbine power plants.

Mr. Richard was graduated from Pennsylvania State College with a B.S. degree in mechanical engineering. He is a member of the Society of Automotive Engineers.

New slide presentation to help your dealers sell themselves

An animated talking cash register acts as master of ceremonies for this unusual slide presentation. As it speaks, color slides are projected onto a screen beside it.

Prepared by Du Pont, this 20-minute educational program is designed for use by oil industry marketing groups in their regularly scheduled meetings with dealers and salesmen. The title is "SELL YOURSELF."

The sales value of improving human relations with customers is the central theme of the presentation. The slides and accompanying script encourage service station attendants to capitalize on the selling power of personal neatness, pleasant, friendly conversation and common courtesy. The fact that women motorists are important, valued customers is also pointed out.

The whole program is wrapped around an interesting plot. The central characters are Joe Wright, an on-the-ball service station operator, and Joe Wrong, a sloppy, unfriendly type of operator. The presentation demonstrates why Joe Wrong's approach is unsuccessful—while on the other hand, Joe Wright's personal selling keeps his cash register ringing.

If you would like to supplement your own dealer training program with one of these "Sell Yourself" presentations, any of our regional offices will be glad to give you full information on obtaining it.

DU PONT
Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • *Wilmington 98, Delaware*

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TULSA, OKLA.—P.O. Box 730 Phone Tulsa 5-5578
HOUSTON, TEXAS—705 Bank of Commerce Bldg. Phone BLackstone 1151
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ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-9141 Printed in U. S. A.

What's Happening. . .

field, as well as petroleum processing and research in special problems. For the past eight years, Dr. Meyer has been research director and manager of the Petrochemical division for Warren Petroleum Corporation.

Ford Builds Exchanger For Gas Turbine

Ford Motor Company has built a heat exchanger which idles at 83 percent efficiency. The development of an exchanger would be a key component in building an automotive-type gas turbine.

Ford's exchanger is a rotary unit, three inches thick and 22 inches in diameter.

Chrysler Corporation, the only other automobile manufacturer which has announced development of a compact heat exchanger applicable to passenger car use, has released no details on its unit.

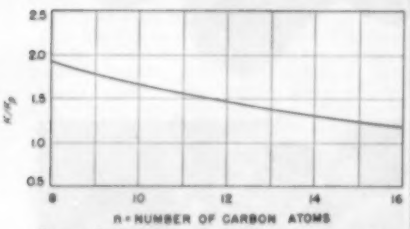

Figure 5. Generalized equilibrium constants.

ERRATUM

The chart shown above is the one that should have appeared at the top, right-hand side, of page 131 in the April issue of Petroleum Refiner over the caption "Figure 5. Generalized equilibrium constants." The figure used in this article by Drs. William G. Domask and Kenneth A. Kobe was the incorrect one.

Also literature cited as shown below was omitted from the April issue.

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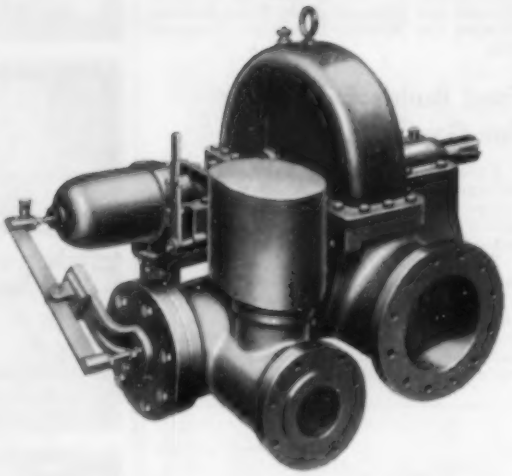

The simplicity and adaptability of the Elliott YR Turbine give it advantages that put it well ahead for pump, fan, compressor and other machine applications. These features all add up to the kind of long-term dependability that makes Elliott the preferred choice among plant engineers everywhere. Bulletin H-22A gives complete details. Write to nearest district office or to Elliott Company, Jeannette, Pa. for your copy.

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Assures alignment cold or hot and simplifies installation. Note how the sturdy exhaust-end pedestal is separated from the hot turbine casing.

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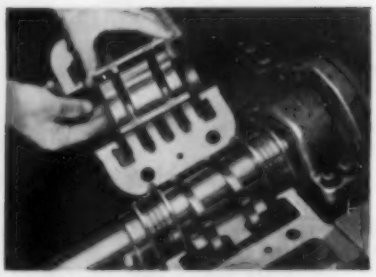
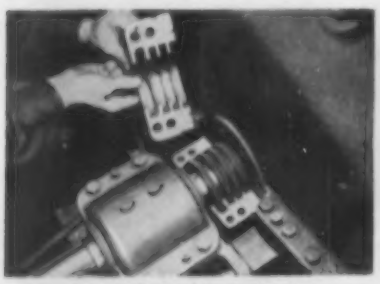
Weather-proofed standard governor, with fly-ball type speed-sensitive element, mounted directly on the turbine shaft, is the simplest, most rugged, and reliable type of governing.



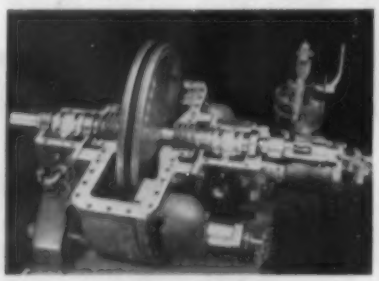
Liner Type Bearings

Bearing cap is easily removable so that the inexpensive liner type bearing can be readily inspected or replaced. Labyrinth seals effectively protect the bearings against the elements.



Accessible Shaft Seals

You don't have to raise the upper half of any YR turbine casing to get at the shaft seal for inspection or ring replacement. Just remove a few bolts and the steam-tight packing gland cover comes off.



Self-Locating Rotor

Permanently fixed locating bearing makes it possible to drop the turbine rotor into perfect position without requiring adjustments.

Interchangeable Components

Renewal parts inventories are reduced by the interchangeability of wearing parts between turbine frame sizes. Possible modifications make turbines suitable for special requirements while retaining parts interchangeability.

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What's Happening . . .

. . . *Among Men* in the Industry

Howard S. Bunn has been elected executive vice president of Union Carbide & Carbon Corporation. He also will serve as a member of the company's Executive Committee.

Bunn, associated with Union Carbide since 1922, has been manager of the Pyrofax Gas division and Carbide & Carbon Chemical Company's Plastics division, as well as vice president of that company and president of Bakelite Company. He had been vice president of Union Carbide since 1953 and a director since 1954.

Robert H. Darling, who was supervisor of plans and coordination in the Construction & Maintenance division at The Texas Company works in Port Arthur, Texas, is now chief engineer with Jefferson Chemical Company, Inc. He will headquarter at Port Neches, Texas.

In his newly-created position, Darling will be in charge of the company's engineering branch, with responsibilities for process engineering, construction, utility distribution, maintenance and laboratory analyses.

Crockett

Cornell

S. A. Swenrud, chairman of Gulf Oil Corporation, has been elected chairman of Goodrich-Gulf Chemicals, Inc., jointly-owned company of The B. F. Goodrich Company and Gulf. He was named as a director of the chemical firm to replace W. G. Moore, who has announced his retirement.

P. W. Cornell, director of Goodrich-Gulf since 1953, has been elevated to vice president in charge of operations, engineering and development. He resigned as assistant manager of Gulf's Chemical department to accept his new position.

The chemical company recently completed negotiations with the U. S. government for the purchase of synthetic-rubber manufacturing facilities at Port Neches, Texas. During World War II, Cornell was assigned to the technical committee which designed and had supervision over the plant.

Another change in Gulf's petrochemical organization came with the appointment of L. O. Crockett as general manager of the Chemical department. He will be assisted by V. N. Hurd, named director of chemical development.

Prior to his new appointment, Crockett was manager of the Chemical Activities unit and also manager of the Manufacturing Department's Technical division. Also a director of Goodrich-Gulf, he is responsible for most of Gulf's relations with the affiliated company.

Henry N. Wade, a process consultant for Stearns-Rogers Manufacturing Company, has received the highest honor in the natural gasoline industry and one of the ranking awards in the petroleum industry. The Hanlon Award was presented to Wade at the Natural Gasoline Association of America's recent convention in Dallas.

Wade is the 19th recipient of the award which is conferred each year by the NGAA for outstanding service to the natural gasoline industry. Donor of the award is natural-gasoline pioneer E. I. Hanlon, chairman of the National Bank of Tulsa.

The presentation was made by former NGAA President J. H. Dunn, president of The Shamrock Oil & Gas Corporation in Amarillo, Texas. The citation read in part:

"With this award today we are officially recognizing the major role played by this man in the technical advances of our industry. We are honoring an engineer who pioneered with original thinking and ideas in the design of natural gas processing plants. His ideas and the resulting plants have given the industry an increased yield of products by more economical means while at the same time improving the ultimate recovery of products from the reservoirs where they originate."

Wade engaged in electrical engineering work with Cutler-Hammer Manufacturing Company in Milwaukee, following his graduation as a mechanical engineer from Cornell University in 1914. He returned to his native California in 1921 and was engaged in various engineering ventures until 1932 when he formed his own engineering firm, Parkhill-Wade, Inc., at Long Beach.

As president and chief engineer of the firm, he designed a number of natural gasoline plants for West Coast producers and built the first large-scale gas dehydration plant in the U. S. for Montana Power & Light Company in Montana. This was the fore-runner of many similar plants.

Wade is most widely known for his designing and building, in 1939, the first high-pressure gas cycling plant for processing two-phase streams from deep distillate wells along the Gulf Coast.

Monroe J. Rathbone, president of Standard Oil Company (New Jersey), has received an achievement award "in recognition of character and achievement representing the ideals of Lehigh University." The award, presented by fellow alumni at a recent meeting of The Lehigh Club of North New Jersey, read:

"Not only in his contributions to the petroleum industry and to Standard Oil Company . . . but also in his service to many civic, educational and religious interests, (he) has earned high, national regard."

Rathbone received a chemical engineering degree from Lehigh in 1921, and in 1954 his alma mater conferred a doctor of engineering degree on him.

W. H. Reber, Jr., a member of The Humble Oil & Refining Company's Engineering division at the refinery in Baytown, Texas, since 1948, has been appointed assistant zone supervisor in the Maintenance and Construction division. He will supervise maintenance and construction in the treating area at Baytown.

Gibson

Northup

Maynard S. Northup and **Harold D. Gibson** have been designated by Esso Research & Engineering Company as senior engineering associates. Both are on the engineering staff at the Bayway refinery in Linden, N. J.

Only nine employes previously had received the title. The designation is granted by the board of directors to outstanding personnel in the research and engineering fields.

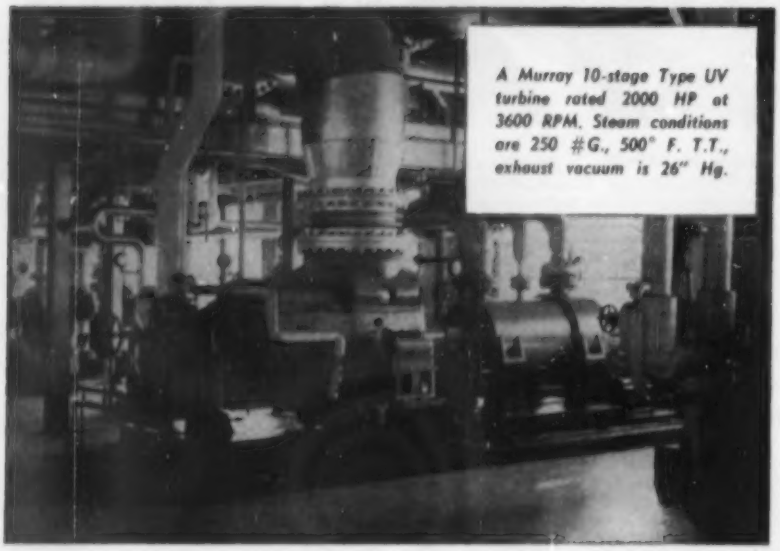
Northup, associated with the company since 1924 and formerly head of the Engineering laboratory, has done considerable work in corrosion and metallurgy. Among his most recent projects was a study of the brittleness of steel used in storage tanks.

Gibson, who joined the company in 1934, has specialised in plant design. He supervised the engineering of the new gas conservation plant operated by Creole Petroleum Corporation in Lake Maracaibo, Venezuela.

Nick P. Peet, with Humble Oil & Refining Company, since 1941, has been promoted to senior technical specialist in the Technical Service at Humble's Baytown, Texas, refinery. He previously had been engaged in special technical assignments.

His work at the refinery had included engineering process furnaces, designing catalytic processes and adapting deasphalting processes to refinery operations. In his new

Murray Turbines



A Murray 10-stage Type UV turbine rated 2000 HP at 3600 RPM. Steam conditions are 250 #G., 500° F. T.T., exhaust vacuum is 26" Hg.

● The Murray Type UV turbine pictured above has been driving a high pressure lean oil pump in a Southwestern refinery for the past 10 years. And is still giving dependable, trouble-free service.

Murray mechanical drive turbines both single and multi-stage can be furnished in a wide range of ratings for steam pressures ranging from 0 to 600 #G., condensing and non-condensing. Types in the higher pressures available for up to 250 #G. back pressure.

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Builders of Steam Power Equipment for Three Quarters of a Century

What's Happening. . .

position, Peet will be responsible for more complex assignments covering a wider scope of refinery activities.

Also receiving promotions with Humble at Baytown are W. A. McElhannon, named senior civil engineer, and R. E. Kappler, appointed mechanical engineer, both in the Design department of the Engineering division. McElhannon is a Louisiana State University graduate, and Kappler graduated from the University of Texas. Peet received his degree from Rice Institute.

Dan M. Krausse, for three years assistant to R. L. Tollett, president of Cosden Petroleum Corporation, has been promoted to manager of manufacturing. Tollett, who also serves as general manager, has been in charge of manufacturing and as his assistant, Krausse has been active in that field.

Krausse

A chemical engineering graduate from the University of Texas, Krausse joined Cosden in 1949, following an assignment with Sinclair Refining Company in the Research and Development department.

A. M. Hovlid, formerly an administrative assistant to Continental Oil Company's manager of industrial relations, is now director of industrial relations for the company's Petrochemical department.

Another new assignment in Conoco's petrochemical organization at Houston is W. W. Clark, promoted to chemical market research assistant. He also had been serving as an administrative assistant.

Jack C. Dart, manager of research and development for Houndry Process Corporation, has been elected as a director of the company.

Dart joined Houdry in 1947, as director of development at the company's laboratories in Linwood, Pa. Before he came to Houdry, he was an instructor in chemical engineering at Texas A&M College and had been associated with Pan American Refining Corporation, Magnolia Petroleum Company and Esso Laboratories.

He holds degree from Albion College and the University of Michigan; is author of several articles on catalytic processing, and holds patents in alkylation, hydrocarbon synthesis and catalytic cracking.

W. F. Stroud, vice president of The Atlantic Refining Company and general manager of manufacturing, has been elected to succeed Harry C. Carr as a director. Carr died recently.

Starting in the Power department at the Philadelphia, Pa., refinery, Stroud has been associated with the refining end of the petroleum industry since he joined Atlantic in 1916. He was elected vice president in 1952.

J. E. Hartman, associated with The Ralph M. Parsons Company since 1953, has been selected as superintendent of the new refinery recently completed by the Turkish government at Batman, near Diyarbakir.

Hartman previously was connected with

Johns-Manville announces the development of new **SIL-O-CEL 16L** *Insulating Fire Brick...*

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Combines outstanding physical and thermal properties for furnace service to 1600F

Check these properties of SIL-O-CEL 16L

Maximum service temperature	1600F, back-up or exposed
Approximate density	33-35 lb per cu ft
Transverse strength	60 psi
Cold crushing strength	350 psi
Linear shrinkage	0.7 percent at 1600F
Reversible thermal expansion	less than 0.1 percent at 1600F
Thermal conductivity (Btu in. per sq ft per F per hr at indicated mean temperatures)	0.92 at 500F 1.07 at 1000F 1.22 at 1500F

1—has less than 0.1% reversible thermal expansion at 1600F

2—provides high load-bearing strength

3—for direct exposure or back-up service

Here is a new development of Johns-Manville insulation and refractory research. Its exceptional characteristics provide important savings in furnace construction. Made of diatomaceous silica, Sil-O-Cel* 16L Insulating Brick is light in weight . . . has low thermal conductivity . . . high structural strength. And where furnace linings are subjected to severe heat shock or where high load-bearing properties are needed, Sil-O-Cel 16L offers outstanding performance.

Sil-O-Cel 16L is now available. Samples will be sent on request. Also available without obligation is Booklet IN-115A, which describes Sil-O-Cel 16L and other J-M Insulating Brick and Insulating Fire Brick for service to 3000F. Write Johns-Manville, Box 60, New York 16, N.Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

*Sil-O-Cel is a Johns-Manville registered trade mark

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The development of Sil-O-Cel 16L Insulating Brick has resulted in the discontinuance of Sil-O-Cel Natural Brick. The outstanding properties of Sil-O-Cel 16L make it the ideal replacement for Sil-O-Cel Natural Brick for back-up use. In addition, the properties of Sil-O-Cel 16L Brick extend its use to exposed service applications.

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What's Happening. . .

Kendall Refining Company at Bradford, Pa.; Sun Oil Company at Toledo, Ohio; Frontier Refining Company at Buffalo, and Bay Petroleum Corporation at McPherson, Kan. He became superintendent of the Bay refinery at McPherson in 1950, and remained there until he joined the Parsons company.

Jeff Davis, secretary of Lion Oil Company since 1931 and now its general counsel, is a new vice president of the company. Also named as new vice presidents: E. W. Atkinson, treasurer since 1943; J. B. Rogerson, who is in charge of manufacturing, and R. C. Tallman, research director.

T. C. Banta, formerly purchasing agent for Sinclair Oil Corporation, has been elevated to vice president of Sinclair Refining Company. Also elected to the refining company's board of directors, he will serve as director of purchases for Sinclair's subsidiaries.

Banta

Banta joined the Sinclair organization in 1930, starting in the Central Engineering department at the East Chicago, Ind., refinery. He transferred to the purchasing department in New York in 1930 and was appointed purchasing agent in 1950.

John R. Rock has been promoted to assistant supervisor of employe relations with Tide Water Associated Oil Company's Western division in San Francisco. He replaces Claude E. Fountain, who has been made assistant to the manager of the company's nationwide employe-relations program.

A Tide Water Associated employe since 1945, Rock joined the company as a training supervisor at its Avon refinery in Associated, Calif. He is a graduate of the University of California, and attended Standard University Graduate School of Business Administration.

Erskine A. Owens, who has been serving Ashland Oil & Refining Company as district manager at Tulsa, Okla., has been transferred to the company's home office in Ashland, Ky. Ashland will close its Tulsa office.

Owens has been with the company since 1952 when he took over the company's newly-established district crude-oil supply office in Tulsa. Before joining Ashland, he was manager of crude oil purchases and sales for Sunray Oil Corporation. He had been associated with Sunray since 1947.

John D. Long, a research and design engineer with Creole Petroleum Corporation, has been named to head the Manufacturing Group in the company's New York offices. He takes over the refining duties relinquished by Lloyd G. Smith, a Creole vice president who will devote full time to his responsibilities as a director.

Long

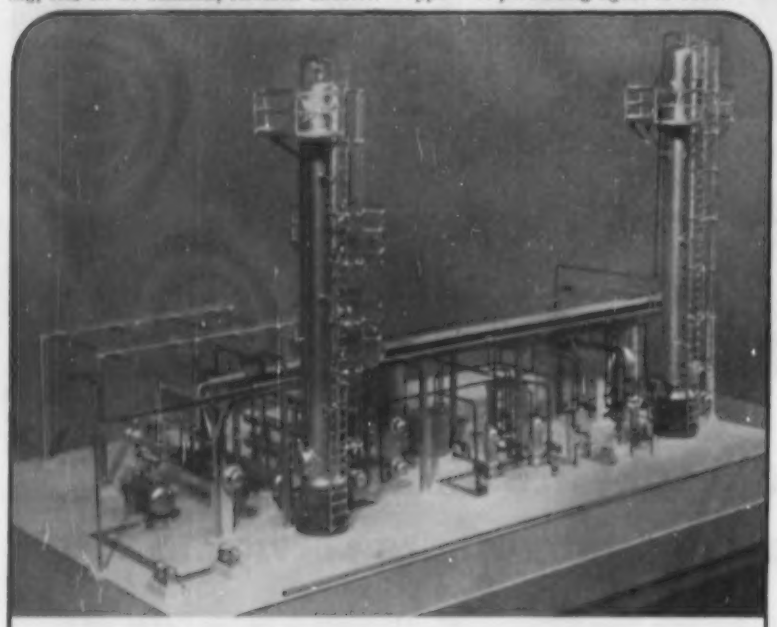
Dr. Long has been associated with the petroleum industry since 1933. He began his career with the Standard Oil Company (New Jersey) group in 1936 when he joined Standard Oil Development Company as a process design engineer at Bayway, N. J. He moved over to Creole in 1945 as technical assistant to the refining manager in Venezuela. He was transferred from Caracas to New York in 1949 as technical assistant to Smith.

F. L. Whitney, Jr., Monzanto Chemical Company, St. Louis, Mo., has been elected president of the National Association of Corrosion Engineers, succeeding Aaron Wachter, Shell Development Company, Emeryville, Calif.

W. F. Fair, Jr., Tar Products division, Koppers Company, Inc., Westfield, N. J., was named vice president, and R. A. Brannon, Humble Pipe Line Company, Houston, was re-elected to a sixth term as treasurer.

Corporate-member directors named were Robert R. Pierce, Pennsylvania Salt Manufacturing Company, Philadelphia, and C. G. Munger, Amercoat Corporation, South Gate, Calif. W. H. Stewart, Sun Pipe Line Company, Beaumont, was elected as active-member director.

James W. Bruskotter, for the past year head of The Ohio Oil Company's Organization Planning department at Findlay, Ohio, will supervise the Business department at a new research laboratory to be built near Littleton, Colo. With Ohio since



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2500 BPSD
CATALYTIC POLY FEED TREATING UNIT

The above model is a scaled down version of the actual project. Now under construction, the new treating unit was designed and engineered by the C. W. Nofsinger Company.

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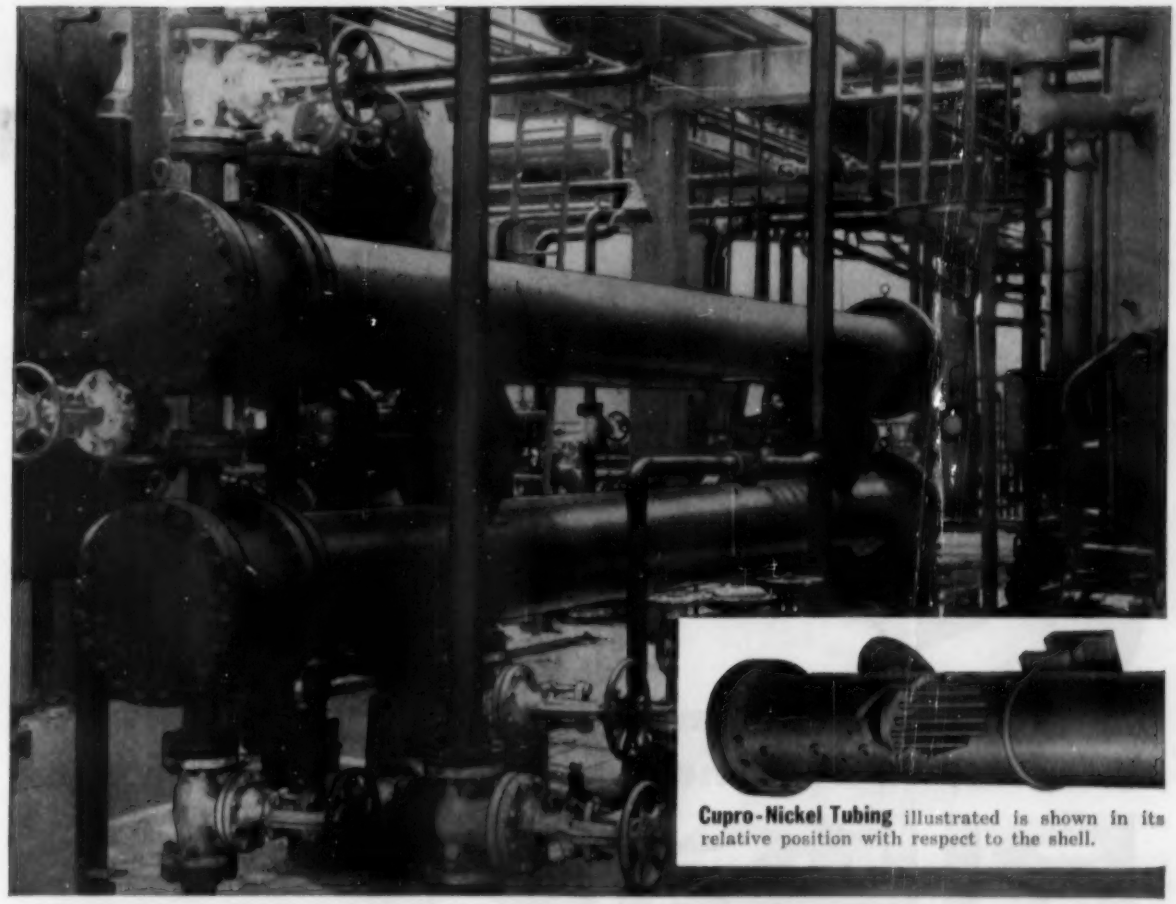

Cupro-Nickel Tubing illustrated is shown in its relative position with respect to the shell.

Large Refinery gets fast liquid-to-liquid heat exchange through cupro-nickel tubing. Counterflow design of this exchanger eliminates need for three or four units. Each of the two shown above has two passes on tube side, and two on shell side. Produced by the Process Equipment Division, ADSCO Industries, North Tonawanda, N. Y.

Speeds heat transfer with tubes of Cupro-nickel

Major refiner cools one liquid 90° . . . heats another 90°

THREE PROPERTIES of cupro-nickel can help you speed heat exchange . . .

First, alloys of this type containing 10 to 30 per cent nickel resist attack by a wide array of corrosive media. Thus, your tube surfaces stay smooth and clean . . . free of heat-obstructing scale and deposits.

Secondly, because of this good resistance to corrosion and the absence of non-conductive scales, or corrosion products, the alloy exhibits good over-all heat transfer.

Thirdly, the combined strength and toughness of cupro-nickel permits thinner tube walls. You thus gain larger inside diameters.

These are the chief reasons why tubes in the units shown here give top performance. Furthermore, cupro-nickel tubes are not subject to dezincification troubles such as are sometimes encountered with brass.

Tubes of cupro-nickel resist pitting, erosion and stress corrosion cracking. And they are ductile enough to permit snug-fitting, durable connections with head sheets.

You will find these tubes giving peak performance under severe conditions. Aboard ship, in power plants, as well as in the process industries.

If heat transfer is your difficulty, call on us for help. We have had wide practical experience in solving this sort of problem.

Let us send you a copy of "Corrosion-Resistance of Cupro-nickel Alloys Containing 10 to 30 per cent Nickel." Yours for the asking. Write for it now.

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What's Happening. . .

Emile E. Soubry, a vice president and director of Standard Oil Company (New Jersey), has been elected to the company's Executive Committee. He has been a member of the board since January, 1949, and vice president for refining since December, 1951.

Soubry

Soubry, who has been associated with the Jersey Standard organization throughout his working years, started as an office boy with the company's British affiliate 43 years ago. A native of London and now a naturalized U. S. citizen, he has served in almost every part of the world where Jersey affiliates do business.

J. E. Roth, vice president and general manager of Tide Water Associated Oil Company's Central division at Tulsa, has been elected to the board of the American Petroleum Institute. He replaces E. H. Salrin, retired vice president of Tide Water Associated.

John P. Peet has been promoted to senior research chemical engineer in the Research & Development division at the Humble Oil & Refining Company refinery at Baytown, Texas. Peet, who joined Humble in 1948, will have responsibility for projects concerned with the processing and product quality of lubricants and fuel oils, as well as with the utilization of residua.

John M. Sprague, manager of The Carter Oil Company's Eastern division operations in Illinois, Indiana, Michigan and Kentucky, has been elected vice president. He will continue to headquarter in Mattoon, Ill.

Rexford S. Blazer, president of Ashland Oil & Refining Company, has been installed as president of the Kentucky Chamber of Commerce. Previously vice president of the state chamber, he had been on the board of directors since 1952.

F. S. Swackhamer, manager of Shell Chemical Corporation's Resins and Plastics department, has been elected vice president of the Commercial Chemical Development Association for 1955 and president-elect for 1956.

R. L. Bateman, director of product development with Carbide & Carbon Chemicals Corporation, is completing his term as CCDA vice president, and will serve as association president for the year beginning July 1, 1955. He succeeds Nolan B. Sommer, connected with American Cyanamid Company's Plastics and Resins division.

J. M. Rogers, head of the Market Development section for Minnesota Mining & Manufacturing Company's Fluorochemicals department, and J. R. Dudley, vice president of research and development with Carwin Chemical Company, were re-elected treasurer and executive secretary for the coming year.

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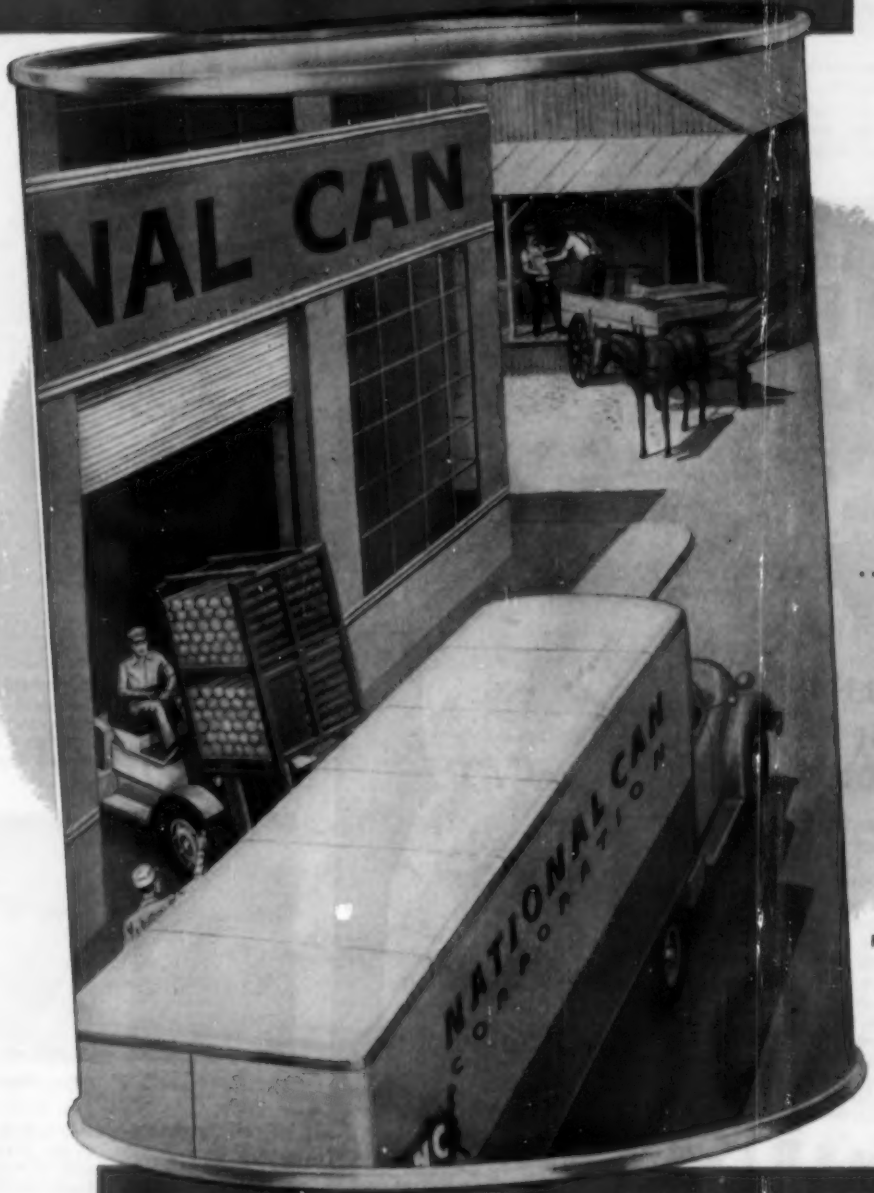
NATIONAL CAN
ON THE MARCH . . .



. . . and we've gone a long way since the horse and buggy days—when NC first came on the scene. The lessons learned in that half century—coupled with a new concept of business responsibility makes National Can a logical source for your can needs.

NC

NATIONAL CAN
CORPORATION

Plants At: BALTIMORE, MD. · CHICAGO, ILL. · MASPETH, N. Y.
CLEVELAND, OHIO · HAMILTON, OHIO *and* WARREN, OHIO

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening. . .

1936, Bruskotter has held various office positions in Tiffin, Ohio, Mt. Pleasant, Mich., and Tampa, Fla.

J. L. Rune has been named senior vice president and executive assistant to the president of The Chicago Corporation. Also elevated to vice presidents are H. N. Seever and L. A. Whitney.

Rune held the post of vice president and general manager of Champlin Refining Company, a wholly-owned subsidiary of the Chicago company. He is being replaced by E. G. Wilmoth, a veteran of 36 years with Champlin.

Jack A. Horner, Shell Oil Company secretary, has been made vice president in charge of licensing for Shell Development Company. In addition to his new post with Shell's research affiliate, he will continue in his present position with the parent company.

Horner

A veteran of 18 years with Shell, Horner has been secretary since 1953. He joined the company as a member of the Legal department, was appointed assistant to the president in 1943 and in 1949, became assistant secretary.

ARCCO

The World Over
wherever there is gas

ARCCO-ANUBIS
'Dry-Air GAS
GRAVITOMETERS

This new Arcco-Anubis Dry Air Gas Gravitometer determines and records specific gravity of gases automatically corrected to the humidity content of the air. The difference in weight between a column of GAS and equal column of DRY AIR is measured. This ratio represents the true specific gravity of the sample.

One bell of the instrument is filled with gas which is being measured, and the other bell is filled with dry air. Otherwise, except for the new instrument having one column for gas and one column for dry air, the unit is identical in operation to the standard gas gravitometer. When calibrated and properly installed, these instruments require little attention other than to wind the clock, ink the pen, and change the chart. Send for bulletin No. 101.

AMERICAN
RECORDING CHART CO.
2113 E. 11th St. • Los Angeles 23, Calif.

Available for Early Delivery

SEND FOR BULLETIN NO. 101

W. K. Robbins has been promoted to senior chemical engineer at The Humble Oil & Refining Company's Baytown, Texas, refinery. With Humble since 1930, Robbins designed much of the equipment used in treating at Baytown. He will continue work on treater modernization and participate in pollution-problem studies.

Robert E. Hulse, vice president and director of National Distillers Products Corporation, is general manager of U. S. Industrial Chemicals Company, a division of National Distillers which will handle all chemical operations for the company.

Previously, U. S. Industrial Chemicals was part of National Distillers' Chemical division. The two now have been consolidated under the established U. S. I. name, with the combined division responsible for the manufacture of products produced by both of the earlier divisions.

Serving with Dr. Hulse are W. P. Marsh, Jr., assistant general manager and vice president of National Distillers; L. A. Keane, U. S. I. vice president; R. H. Cornwell, director of production; S. Schott, research director; F. Olmsted, who is in charge of development; J. S. Atwood, manager of engineering development, and E. A. Yeager, who handles legal affairs.

Lyle E. Martin has been appointed as district engineer for the Asphalt Institute's First division, headquartered in New York. The Kennebunk, Me., engineer formerly worked with surface design and construction of air fields in Alaska, Greenland, Morocco and South America.

P. E. Kuhl has been appointed to fill a vacancy on the board of Iranian Oil Refining Company. The vacancy was created by the resignation of D. L. Hussey.

E. J. Anglin has been appointed by Sinclair Oil Corporation as assistant to P. W. Thirtle, vice president and principal budgetary officer. Anglin had been a member of the company's Comptrollers department since 1948.

Fortney

Martin

W. H. Fortney has been promoted to general shops foreman in the Maintenance & Construction department at Humble Oil & Refining Company's Baytown, Texas, refinery. He is succeeded as foreman of the Instrument department by his former assistant, J. Raymond Martin.

Fortney had been doing instrument work since 1923 and been foreman of the Instrument department since 1937. As general shops foreman, he will be in charge of production in the refinery's craft shops.

Martin, assistant instrument foreman since 1948, had served a year, in training assignment, as general instrument foreman. In his new position, he will be responsible

For more data on advertised products, use Readers' Service Cards, last page.

Follow-thru service makes Ansul Sulfur Dioxide your best buy

Your order for Ansul liquid sulfur dioxide includes more than the product, it includes a good measure of service—the kind of service that starts before the chemical is delivered and then goes on and on. We call it follow-thru service.

From the first meeting with your Ansul representative, 40 years experience in the application and handling of liquid sulfur dioxide becomes available to help solve your particular problem. Very often, shipping and handling details worked out with the Ansul representative result in dollar savings. On-the-spot application assistance is, of course, always available when you feel it is needed.

For example, over the years we have been privileged to work with a number of petroleum processors employing the Edeleanu Process. This experience in the field of sulfur dioxide aromatic extraction is at your disposal.

When you order Ansul liquid sulfur dioxide, you can be sure of product purity, dependable delivery and all the service assistance you require. Write for more information. ANSUL CHEMICAL COMPANY, Dept. C-69, Marinette, Wisconsin.

ANSUL

For more data on advertised products, use Readers' Service Cards, last page.

Use your process stream

to

NITROGEN DIVISION ALLIED CHEMICAL

STOP CORROSION

You can actually make your process stream stop its own corrosive action. Injected into the process lines, Barrett® Brand Anhydrous Ammonia flows right along with the gas stream, neutralizing corrosive hydrogen sulfide all along the way.

Hooked up directly from cylinders, Anhydrous Ammonia is easily vaporized. It stays with the gas stream through condensers, fractionating tower, heat exchangers, storage tanks, etc. Products of neutralization are easily eliminated; excess ammonia is removed by blowing the oil with air.

Normal operating schedules remain the same with Anhydrous Ammonia. Ammonia remains effective under a variety of climatic and operating conditions. At the same time its high solubility and high diffusion rates make it more efficient than other anti-corrosion agents.

Find out now how to preserve your valuable refinery equipment. Use Barrett Anhydrous Ammonia, available in 150, 100 and 50-lb. cylinders. Bulk quantities are also available.

Look for the green cap!

For technical assistance call or write your nearest Nitrogen Division office.

First in Ammonia Since 1890

NITROGEN DIVISION

ALLIED CHEMICAL & DYE CORPORATION

40 Rector Street, New York 6, N. Y.

Hopewell, Va. • Ironton, Ohio • Orange, Tex. • Omaha, Neb.

What's Happening. . .

for the maintenance, repair and operation of all instruments at the Baytown refinery.

Fortney is vice president of the Instrument Society of America. One of the leaders in the organization of the Houston Instrument Society, he served that group as its first president.

David W. Young, holder of several patents in the petrochemical field, has joined Sinclair Research Laboratories, Inc., as a research associate. Young will be given latitude to continue Sinclair investigations in various fields. His research has been in diversified areas, but mostly in petrochemicals.

Young

Robert F. Duncan has been elected executive vice president and treasurer of Calumet Refining Company. Secretary and treasurer since 1950, he also had been manager of Calumet's Package Products division for the past year.

M. Voogd, who has been managing the butadiene plant at Torrance, Calif., now heads Shell Chemical Corporation's combined butadiene-styrene-copolymer operations. Serving as superintendent under Voogd is G. S. Williamson, who held a similar position at the butadiene plant before it was acquired from the government.

A new Marketing division, set up to handle synthetic-rubber sales, is headed by J. P. Cummingham, who was manager of the Product Development department in New York. J. E. Toevs, formerly chemical sales manager in Los Angeles, has been appointed sales manager for the new division headquartered at the Torrance plant site.

Additional appointments in the new manufacturing group: E. S. Martin, senior technologist, and D. A. Limerick, operations manager at the butadiene plant, both named assistant superintendents.

J. Levanda, told to continue as chief engineer at the plant; M. L. Sagenkahn, chief technologist at Martinez, Calif., assigned to a similar post at Torrance; A. H. Anderegg, assistant chief chemist at Houston, transferred to Torrance as chief chemist, and W. C. Bevil, treasury manager in Houston, moved to Torrance to take over a smiliar position.

Voogd

C. F. Beatty, director in charge of industrial relations, purchasing and paint manufacturing for Socony-Vacuum Oil Company since 1946, has retired after 30 years service.

Charles Spahr, recently elected vice president of The Standard Oil Company of Ohio, is one of three new directors of the company. The appointments were made in a move which increases the board's

What's Happening. . .

membership from seven to ten.

Others elected to the Sohio board are Thomas F. Patton, assistant president of Republic Steel Corporation in Cleveland, and Lawrence A. Appley, president of the American Management Association in New York.

Harold J. Maddock has been advanced to chief technologist at Tide Water Associated Oil Company's refinery in Associated, Calif. He will be replaced as assistant chief technologist by James F. Dehnert.

Maddock

Maddock, who joined Tide Water as a laboratory chemist in 1943, was on leave of absence with the Petroleum Administration for Defense in Washington, D. C., for nine months in 1953. Dehnert started with the company as a junior chemist in 1946.

Don F. Steinke, who has been director of power education for The Dow Chemical Company for the past several years, has accepted a position as overseas coordinator of training for Standard Vacuum Petroleum Maatschappij. The company is a wholly-owned subsidiary of Standard Vacuum Oil Company headuartered at The Hague, in the Netherlands.

Steinke will be stationed in Sumatra. Among his duties will be the administration of American schools for company employes, vocational and apprentice schools, management development and scholarship awards.

He has authored nine training textbooks and developed lesson plans and training facilities. In 1946 he helped for the Industrial Audio Visual Association, serving as secretary since its formation.

Alan C. Tully, associated with Ethyl Corporation for more than 25 years, has been elected president of Ethyl Corporation of Canada, Ltd., a newly-formed subsidiary which will replace Ethyl Antiknock, Ltd. The new company will build an antiknock compound manufacturing plant at Sarnia, Ont.

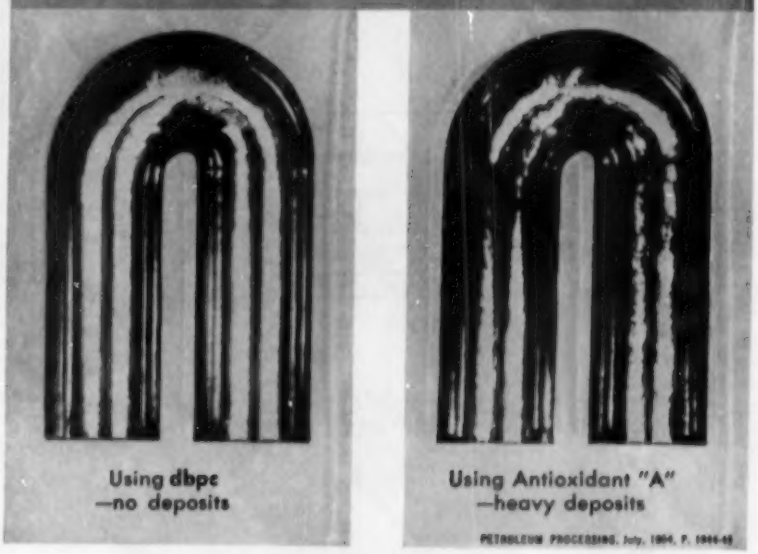
Named to serve as Tully's vice president is Oscar B. Lewis, formerly vice president of Ethyl Antiknock. Robert T. Edgar was selected as manager of the plant to go up at Sarnia.

Tully, a native of England, has been engaged in U. S. and foreign sales for the company. At one time he was in charge of Ethyl's operations in Australia and the Far East.

W. C. Hewitt, general operating superintendent for Phillips Chemical Company at Bartlesville, Okla., has been elevated to assistant general manager in a series of promotions made in connection with the acquisition of the Plains Company butadiene and copolymer plants at Borger, Texas. Others moving up in the Phillips organization:

A. J. Head, Philblack plant superintendent at Borger, named director of the chem-

HERE'S PROOF!—



dbpc® Antioxidant

does not contribute to manifold deposits

Two popular antioxidants—**dbpc** inhibitor* and a well-known commercial gasoline gum inhibitor — were tested in a blend containing 60% catalytic cracked and 40% thermal cracked gasolines. The manifold test unit employed in the experiment consisted of the specially-designed manifold shown here, attached to a single-cylinder, air-cooled engine, with provisions for control of fuel rate and temperature. The air-fuel mixture from the carburetor entered the manifold which was heated by two 500-watt, pancake electric heaters attached to the manifold exterior. Manifold temperature averaged 255° F. Photographs above show identical sections of the two test manifolds.

Operational tests were made on both antioxidants and the results showed that **dbpc** did not contribute to manifold deposits. (Left photo). On the contrary, it actually tended to *reduce* deposits. Antioxidant "A," on the other hand, *increased* manifold deposits, as shown in the right hand photograph.

In addition to this outstanding feature, **dbpc,** *pound for pound, is the most economical gasoline antioxidant in use today.*

dbpc is also supplied in easy-to-handle liquid form as Impruvol 33® antioxidant. For information write:

* 2, 6 di-tert-butyl-para-cresol

KOPPERS COMPANY, INC.

Chemical Division, Dept. PR-55, Pittsburgh 19, Pennsylvania

CHEMICAL PROGRESS WEEK—MAY 10-21

KOPPERS

Koppers Chemicals

SALES OFFICES: NEW YORK · BOSTON · PHILADELPHIA · ATLANTA

CHICAGO · DETROIT · LOS ANGELES · HOUSTON

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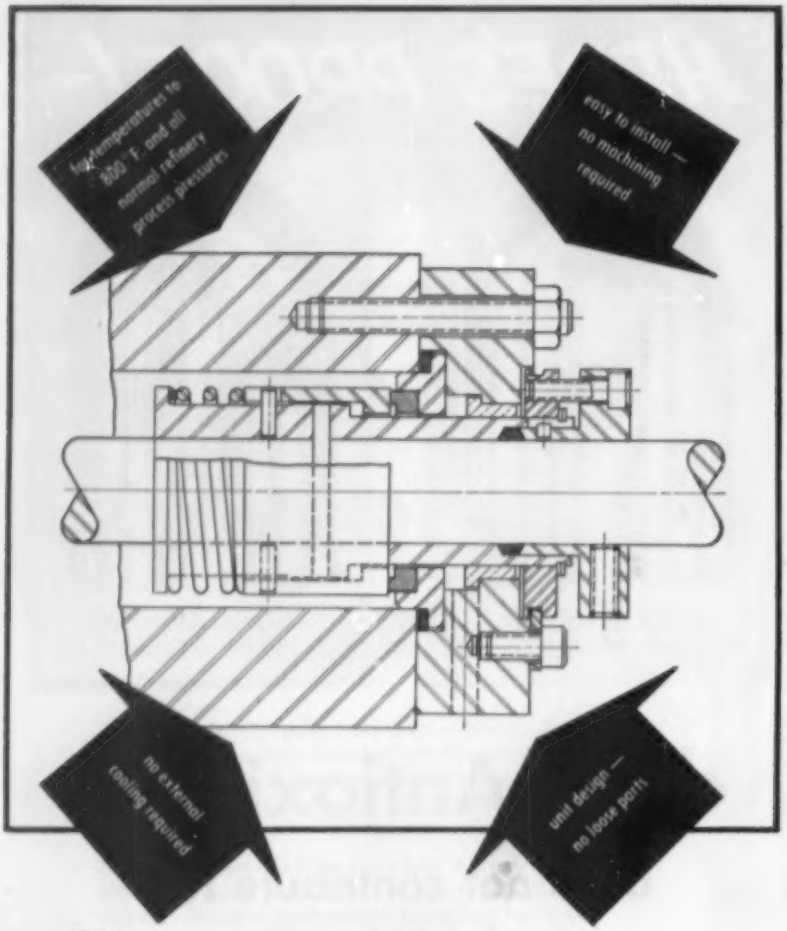

high temperatures to 800° F. and all normal refinery process pressures
easy to install — no machining required
no external cooling required
unit design — no loose parts

NEW SEAL FOR HOT PUMPS

Equipped with the new Sealol HT Mechanical Shaft Seal, your process pumps can now easily handle pumping temperatures to 800°F. with *no external coolant*. This new seal takes hot bottoms and other high temperature refinery products in stride. High temperatures are safely handled by this metallic seal. Shaft scoring is eliminated, and pump maintenance is reduced to a minimum.

Get the complete details on this simple, economical Sealol Seal . . . send for data sheet B-11. Also ask us for engineered recommendations on your sealing problems, whether for high or low temperatures.

SEALOL CORPORATION, 185 POST ROAD, PROVIDENCE 5, R. I.

Baton Rouge • Charleston (W. Va.) • Chicago • Cleveland • Corpus Christi • Dallas Houston • Los Angeles • New Orleans • New York City • Philadelphia • San Francisco St. Louis • Tulsa • Edmonton — Toronto (Can.) • Manchester (Eng.) • Paris • Frankfurt

SEALOL

THE BALANCED PRESSURE SEAL

What's Happening. . .

ical company's Manufacturing division and moved to Bartlesville; A. B. Leonard, Plains plant superintendent at Borger, assigned to the offices at Bartlesville as director of the Rubber Chemicals division.

G. H. Short, assistant plant superintendent at Borger, made to replace Leonard as superintendent of the Plains plant; H. E. Halton, superintendent of terminating operations at Houston, returned to Borger as Philbrick superintendent, replacing Head.

W. R. Pittman, maintenance and mechanical superintendent at the Houston terminal, assigned to succeed Halton as terminating superintendent, and H. D. Trotter, mechanical superintendent at the Phillips Petroleum Company refinery in Kansas City, sent to Borger as Plains plant assistant superintendent.

Russell H. Green has been elected to a newly-created position as executive vice president of Signal Oil & Gas Company. He formerly was vice president in charge of the Oil Producing department.

Green

Other new appointments in the company's executive staff include Harold F. Clary, a director, named vice president, and A. E. Stebbings, elected assistant secretary.

Col. William C. Snyder has resigned as chief petroleum officer for the Air Force's Strategic Air Command, to rejoin Sinclair Refining Company. Following a refresher and indoctrination tour of Sinclair refineries, he will succeed William A. Tracey as government sales representative for Sinclair.

Tracey retires after six years as Washington representative and a long period with the company in other capacities.

James H. Curtis has been elected vice president of The Lummus Company. At one time manager of manufacturing for General Petroleum Company, Curtis formerly was assistant to the president of Lummus.

In other Lummus appointments, D. R. Breien, company treasurer, was elected secretary and treasurer; Mario J. Marchione, assistant treasurer was named assistant secretary and assistant treasurer, and Theodore F. Brophy, company counsel, was made assistant secretary.

Breien has been associated with the Lummus organization for the past 21 years.

David P. Parker has been appointed manager of the Socony Mobile Oil Company, Inc., refinery in Brooklyn. He succeeds Dr. William L. Linton, manager of the refinery since 1938.

Parker has been with the company since 1934. He started in the refinery at Augusta, Kansas and in 1938, was transferred to the company's East St. Louis, Ill., plant. He was named manager of the Technical division at East St. Louis in 1947. Three years later he was assigned to Vacuum Oil Company, a British affiliate, and served as manager during the

For more data on advertised products, use Readers' Service Cards, last page.

THIS PLANT SPECIFIED 1412 FEET OF MALTESE CROSS!

At this new plant of the National Petro-Chemicals Corporation at Tuscola, Illinois, 113 lengths of Hewitt-Robins Maltese Cross® LP-Gas Hose and couplings are used to load propane and other hydrocarbons at the rate of 27 tank cars and 30 tank trucks per day. Maltese Cross was specified to insure steady production, eliminate chance of costly breakdowns, because it's safer . . . stronger . . . tougher . . . resists penetration of liquefied petroleum gases . . . is easier to handle!

Whether you're handling liquids or gases, Hewitt-Robins can benefit your operation with maximum hose safety, economy and performance. We manufacture over 1,000 types of industrial hose; there's one to meet your need!

ENGINEERING DATA

MALTESE CROSS PROPANE HOSE—Synthetic Tube and Cover, Braided, Mandrel Cured.

TUBE: Thick, compounded synthetic, specially formulated to resist the destructive permeating action of liquefied petroleum gases.

CARCASS: Strong, braided rayon cord, impregnated in resilient synthetic rubber, closely braided at correct angle to withstand highest pressures. Spiral of non-corrosive wire in the hose wall dissipates static. Positive electrical connection is assured by factory testing every length.

COVER: Tough, tan weather- and abrasion-resistant. Will withstand prolonged exposure to sunlight and abuses common to propane service.

Hewitt-Robins

Industrial Hose—Conveyor Belting—Conveyor Machinery—Vibrating Screens—Vibrating Conveyors—Design, Manufacture, Engineering and Erection of Complete Bulk Materials Handling Systems.

HEWITT-ROBINS INCORPORATED • STAMFORD, CONNECTICUT

For more data on advertised products, use Readers' Service Cards, last page.

Stainless Steel Plates
ready for fabrication
accurately produced by
G. O. CARLSON, INC.

FABRICATORS time and time again turn to G. O. Carlson, Inc. for what they need in stainless steel. These fabricators know that Carlson's experienced specialists in Engineering and Production plan their work . . . for accuracy, for economy, for prompt delivery.

The patterns illustrated are typical. Made from Type 304 stainless, these blanks are sheared and sawed from ¾" plate to 16½" x 23½" dimensions. One 8⅛" diameter hole and twenty 2½" diameter holes were machined in these patterns to give the fabricator pieces requiring only a minimum of additional work before actual fabrication.

It is this "done right" aspect of Carlson workmanship that has built a service on which customers fully depend. For your work in stainless, let Carlson do it—and be completely satisfied. We'll gladly answer your inquiry without delay.

Stainless Steels Exclusively

G. O. CARLSON, INC.

Plates • Plate Products • Forgings • Bars • Sheets (No. 1 Finish)

THORNDALE, PENNSYLVANIA

District Sales Offices in Principal Cities

What's Happening. . .

construction and initial operation of a new refinery at Coryton, England. He has been assigned to the company's headquarters in New York since last summer.

Paules

Charles E. Paules has been named vice president of Esso Research & Engineering Company, succeeding Eric Luster, who died April 2. Paules has been with the company, Standard Oil Company (New Jersey) research affiliate, since 1919.

J. Frank Drake, president of Gulf Oil Corporation for 17 years, has retired as chairman of the company's Executive Committee. He will continue as a director and member of the board's Finance committee.

Drake joined Gulf as an assistant to the president in 1919. He became president of the company in 1931 and was elected chairman of the board in 1948. Five years later he was elected to Gulf's Executive Committee.

Deaths:

Gustav Egloff, one of the world's foremost petroleum scientists and director of research for Universal Oil Products Company, died in Chicago, following a brief illness. He was 69 years old.

Known as "Mr. Petroleum" in the scientific world, Dr. Egloff was author of 650 articles and 11 books relating to the petroleum industry and chemistry of hydrocarbons. He had more than 300 patents to his credit on the processing of petroleum oil, coal and shale oil.

He was vice president at world power conferences in London in 1928 and 1950, Berlin in 1930 and Washington in 1936, and had lectured in nearly every section of the world. He had been a delegate to 11 international meetings on oil and had lectured in nearly every section of the world.

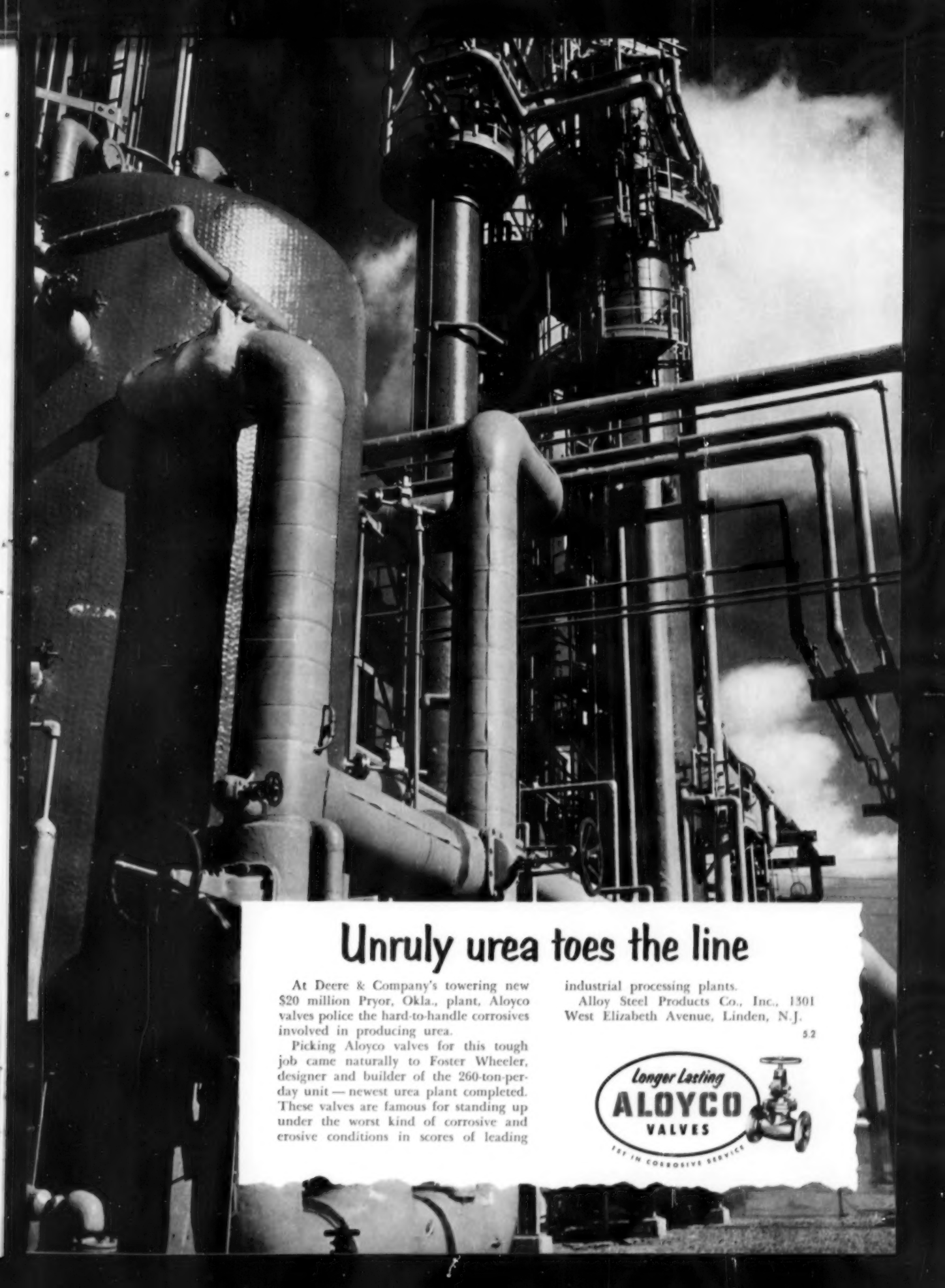
A member of at least 17 technical societies in which he had served as an officer, Dr. Egloff had been awarded 22 honorary degrees, fellowships and awards. He was honored by 34 foreign countries.

Born in New York City of Swiss parents, he was graduated from Cornell University in 1912 and received master's and doctor's degrees from Columbia University. He joined the U. S. Bureau of Mines in 1915 and later served Aetna Chemical Company. He was appointed director of research for UOP in 1917 and was active in that position until his death.

Alfred B. Strickler, industrial engineer for Esso Research & Engineering Company at Linden, N. J., died March 29 of a heart attack. He was 60-years-old.

Don Jacobs, technical adviser to Mid-Continent Petroleum Corporation at its West Tulsa, Okla., refinery, died March 11, following a heart attack. He was 61 years old.

For more data on advertised products, use Readers' Service Cards, last page.



Unruly urea toes the line

At Deere & Company's towering new $20 million Pryor, Okla., plant, Aloyco valves police the hard-to-handle corrosives involved in producing urea.

Picking Aloyco valves for this tough job came naturally to Foster Wheeler, designer and builder of the 260-ton-per-day unit — newest urea plant completed. These valves are famous for standing up under the worst kind of corrosive and erosive conditions in scores of leading industrial processing plants.

Alloy Steel Products Co., Inc., 1301 West Elizabeth Avenue, Linden, N.J.

5.2

Longer Lasting
ALOYCO
VALVES
TRY IN CORROSIVE SERVICE

DEPENDABILITY

Weston thermometers with Multiple bimetal helix

The reasons why WESTON all-metal industrial thermometers excel in dependability and long life . . . enjoy such outstanding preference throughout industry . . . stem in large part from Weston's exclusive design and manufacturing methods. The critical *sensing elements* are all Weston-made in the shorter *multiple helix* form to insure rugged, *nonsagging* units. They are then *cycle-seasoned,* over broad temperature ranges, to insure *consistently precise indications* over far longer periods. Thus they serve better, longer, at far lower over-all costs. Bulletin containing sizes, ranges and prices, available on request. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Ave., Newark 5, N. J.

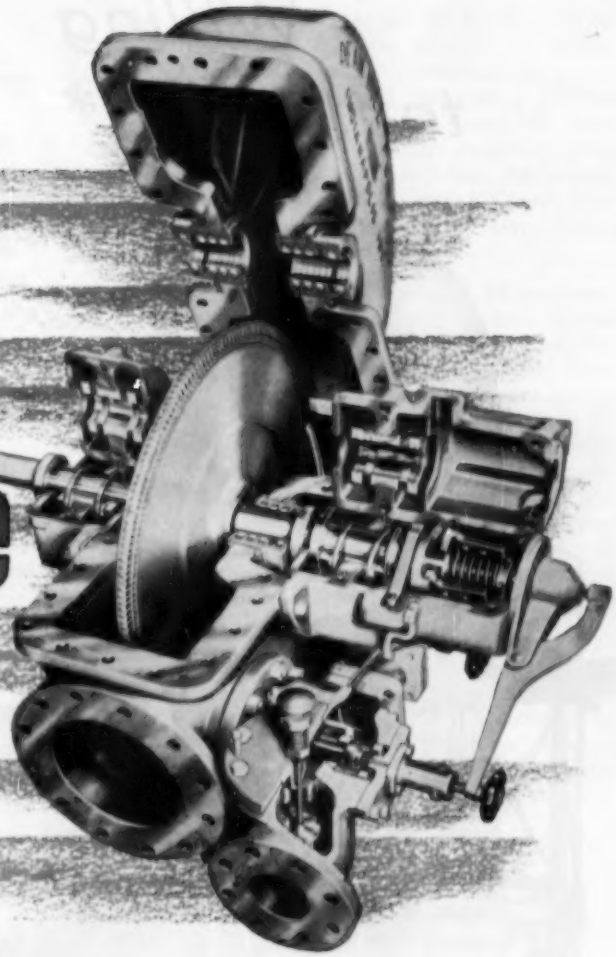
WESTON

Thermometers

AVAILABLE THROUGH LEADING DISTRIBUTORS

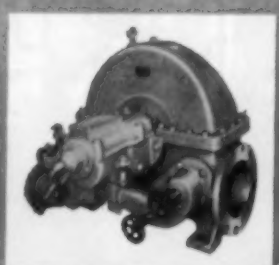
For more data on advertised products, use Readers' Service Cards, last page.

up to 100% more power



added to DH turbines

More power from the same size unit! Dean Hill presents an improved DH Line of horizontal turbines which produce up to twice the power of former counterparts.



The major change contributing to this tremendous power increase is the addition of one or more steam nozzles to all models, with these results . . .

1. The new, two-nozzle DH-10 and DH-20 turbines have *double* the maximum horsepower of former units.

2. Models DH-30, DH-40 and DH-45, now with three nozzles, are rated 50% higher in maximum horsepower.

FULL INFORMATION AVAILABLE

Many other improvements have been made on the five DH Models, adding to the quality and performance of Dean Hill Horizontal Turbines. A new catalog completely describes these models, and this information will be sent you on request.

Write Today For Dean Hill's New Turbine Catalog No. 500.

DEAN DH HILL PUMP COMPANY

Pump and Turbine Engineers Since 1893

Indianapolis 7, Indiana

Sales Offices in:

Chicago, New York, San Francisco, Boston, Cincinnati, Denver, Albuquerque, El Paso, Salt Lake City, New Orleans, Philadelphia, Tulsa, Los Angeles, Pittsburgh, Houston, Dallas, St. Paul, Toledo, Cleveland, Grand Rapids, Birmingham, Ala., Louisville, Memphis, Nashville, Richmond, Bogota, Col., Mexico City, Montreal, Reading, Pa., The Hague

For more data on advertised products, use Readers' Service Cards, last page.

Willing to find out*

The Research Division is another facet of Fluor's multi-service operations under a single responsibility. The Research Division designs new or improved processes and products which are offered by Fluor to industry. It conducts laboratory and pilot plant experimental studies to provide technical data to other Fluor divisions and to their customers. It furnishes consulting services in fields of specialized knowledge, and maintains a broad contact with the technical and economic trends of the industries it serves.

BE SURE WITH **FLUOR**

THE FLUOR CORPORATION, LTD.
LOS ANGELES 22, CALIFORNIA, U.S.A.

FLUOR OF CANADA • TORONTO
HEAD WRIGHTSON • LONDON
AFFILIATES: BINGHAMTON & DREYER, NEW YORK; H. G. ACRES & COMPANY, LTD., NIAGARA FALLS, ONTARIO, CANADA

ENGINEERS
CONSTRUCTORS
MANUFACTURERS

NEW YORK
CHICAGO
PHILADELPHIA
BOSTON
PITTSBURGH
SAN FRANCISCO
HOUSTON
BIRMINGHAM
TULSA
DENVER

There are many practical advantages of dealing with an engineering and construction firm that appreciates the value of research, who has the manpower and facilities to conduct a thorough research program concurrently with engineering and construction (no need to delay a construction project while research is being concluded), and who possesses an unbounded willingness for finding out. For more information on Fluor's Research facilities write for Bulletin FC 8.001R.

*"Research means you do not know but are willing to find out" —CHARLES KETTERING

Heard at Meetings . . .

Advances in Distillation*

. . . **The complex mixture** of oxygenated chemicals produced by the partial oxidation of aliphatic hydrocarbons contains several groups of close boiling compounds and numerous azeotropic systems. Isolation of pure products by ordinary fractionation is therefore not possible. The differences in the polarity of the several homologous groups can however be used to effect separations by azeotropic and extractive distillation Typical applications show how a polar or non-polar entrainer or solvent alters relative volatility of the key components and permits a pure product to be recovered from a complex fraction (W. C. Hopkins, Celanese Corporation of America, Clarkwood, Texas, and J. J. Fritsch, Celanese Corporation of America, Bishop, Texas).

. . . **The separation** of butenes-2 from normal butane is accomplished at the Plains Butadiene Plant by the use of a furfural extractive distillation column. Recently a dynamic study has been made of the column control. The primary control element is an infrared analyzer which continuously determines the butenes content of a sample from the vapor phase of a tray midway between the feed entry and the reboiler. The control signal from the analyzer's recorder is used to reset the lean furfural flow rate and thereby control the column's separation. A study of the data revealed that several hours are required for the column to return to the desired operating conditions following minor upsets as may be caused by changes in feed rates and other parameters. From the preliminary consideration of control problems it was concluded that a greater knowledge of the dynamics of the system was necessary to more nearly approach optimum control. Perhaps an analysis by frequency response techniques will offer a better method of interpretation than the five days of routine operating data in this test (G. G. Campbell, Phillips Chemical Company, Borger, Texas, and D. E. Berger, Phillips Petroleum Company, Bartlesville, Okla.).

. . . **A method** has been developed for estimating the point efficiency in a bubble cap plate from compositions of entering and leaving streams, taking into account the actual degree of liquid mixing on the plate. A correlation of degree of mixing for ethylene dichloride-toluene distillation on an 18-inch column with three plates each having ten 3-inch caps was obtained. Further data showing the effects on efficiency of composition, pressure, slot velocity and liquid depth were presented (E. D. Oliver and C. C. Watson, University of Wisconsin, Madison, Wis.

. . . **A theoretical** equation was developed for predicting the specific heat at constant volume and constant pressure of organic liquids as a function of temperature from data on the velocity of sound, infrared and Raman spectra. Using this equation, the average deviation of the calculated from the experimental values of specific heat for 100 liquids of 68 degrees F is plus or minus 1.5 percent. An alternate correlation for hydrocarbon liquids based on a modified statement of the theory of corresponding states gave an average deviation of plus or minus 0.9 percent (B. C. Sakiadis and J. Coates, Louisiana State University, Baton Rouge, La.).

. . . **The operating** characteristics of a centrifugal extractor were investigated for the following variables: density difference, rotor speed, light-liquid-out pressure, flow rates, holdup and number of stages. A technique for holdup determination that comprises displacing either phases in the extractor with the other phase was described and experimentally demonstrated. An equation useful in predicting flood limits was also verified. (F. M. Jacobsen and G. H. Beyer, Iowa State College, Ames, Iowa.)

. . . **The different** processes for the manufacture of carbon black from gaseous hydrocarbon are governed by two independent objectives, the most efficient release of carbon black from the hydrocarbon and the develop-

* AIChE, Houston, May 1-4, 1955.

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Who's Meeting . . .

ment of physical and chemical properties required in the carbon black. Attainment of these objectives are still controlled largely by empirical methods. The mechanism of carbon formation from gaseous hydrocarbons involves two steps, the preliminary partial dehydrogenation of the hydrocarbon at elevated temperatures by either pryolytic or oxidative reactions and its subsequent polymerization to cyclic hydrocarbons. The most significant property of carbon black for practically all applications is fineness. Fineness control during solid phase formation is important and is governed by the dilution ratio of hydrocarbon and air, with temperature and turbulence in the flame as significant contributor factors (C. W. Sweitzer and G. L. Heller, Columbian Carbon Company, New York).

Petroleum and the Seaway*

. . . The completion of the St. Lawrence Speedway may mean such an expansion of consumption in the Great Lakes area that additional refinery facilities in the Lake Erie Basin may be forthcoming. But don't expect any immediate impact on petroleum transportation. The most important reason is that the trend in transportation of petroleum in the Great Lakes is away from water transportation to pipe lines. Also the most efficient transport of petroleum by water is in much larger ships than can be accommodated in the seaway.

Further the time of transit and the toll cost must be considered as adverse factors. (N. R. Danielian, Great Lakes St. Lawrence Association.)

Reboiler Heat Balance†

. . . A new method for estimating the overall temperature driving force (and hence overall heat transfer coefficients) corresponding to any heat flux value for vertical thermosiphon reboilers has been developed. The new method predicts the existence of the liquid zone and utilizes existing correlations for convection heat transfer to estimate the coefficients for the vaporization zone. In developing the

† AIChE at Louisville. April 13-15, 1955.
* AIChE at Louisville.

Who's Meeting . . .

method, circulation rates and overall temperature driving forces were measured using a steam heated vertical thermosiphon reboiler of standard design. The tube bundle contained 96 1-inch x #12 BWG carbon steel tubes 8 feet long. Inlet and outlet nozzles were 6 inches and 10 inches respectively. The reboiler was operated at heat fluxes up to 16,000 Btu/(hr)(sq ft). Temperature profiles through the central tube of the bundle were observed using a thermocouple probe. The temperature profiles indicated that vaporization did not occur until the liquid had passed through approximately one quarter of the tube length. Circulation rates could be predicted fairly successfully by a modification of Kern's method including the existence of a liquid zone and using the two phase pressure drop correlation of Martinelli and Lockhart for the vaporization zone. (A. I. Johnson, DuPont Company of Canada Ltd., Maitland, Ontario.)

. . . **A new** correlation has been developed for predicting the pressure-volume-temperature relations of nonpolar (and slightly polar) gases. The correlation is a modification of the law of corresponding states in which a third parameter, the slope of the pseudo-critical isometric in dimensionless form (S), is introduced in a simple manner: multiplying the reduced pressure and temperature of the gas by a factor which can be easily calculated or read from a graph. This gives the corrected reduced pressure and temperature which can then be used with a generalized compressibility factor chart in place of the true value. The correlation is accurate for densities up to about 1.2 times the critical density. (Oscar T. Bloomer and R. E. Peck, Illinois Institute of Gas Technology, Chicago, Ill.)

. . . **Rocket** propellant history and major developments in propellant manufacture were described in seven papers. In just ten years the propellant industry has advanced from bench-scale to large-scale production. This growth is largely the result of the tremendous potential of propellant power for the military. Im-

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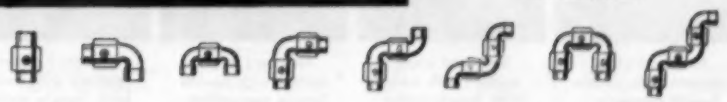

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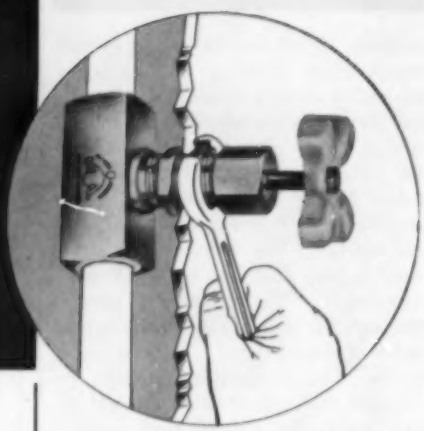
For panel mounting with double female connections.

For panel mounting with male inlet; female outlet.



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- **Deep throats and thread chambers** —for tight make-up of piping.
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- **Clear markings.** Bodies marked in accordance with M.S.S. regulations showing size, material, service symbol, maximum pressure.

The standard series is shown opposite.

Who's Meeting . . .

provements in quality and controlled methods of manufacture are widening the use of propellants for peaceful purposes, however. Propellants are characterized by their ability to liberate large quantities of energy by combustion without an external source of oxygen. Their compactness and low cost make them very attractive for industrial application. Laboratory evaluation of propellants, scale-up techniques and the engineering and safety problems encountered in process design and operation were covered in the symposium.

. . . **Recent** studies indicate that agitation can improve the heat transfer coefficient over the entire boiling curve. Prior workers have studied the two ends of the boiling curve and have shown that agitation can increase the heat transfer coefficient for nucleate and film boiling. This new work was concerned with the critical temperature difference and the transition region of boiling. Methanol was boiled at atmospheric pressure while being agitated with a 3-inch, 3-bladed propeller at speeds up to nearly 1000 RPM. Heat was supplied by a ⅜-inch x 6-inch steam-heated copper tube located in a horizontal position within one inch of the propeller blades. The critical temperature difference for copper to methanol was about 51 F and was independent of the degree of agitation. The heat transfer coefficient throughout the entire transition region and also at the critical temperature difference was increased as agitation increased. The maximum increase in heat transfer due to agitation was over 100 percent. (F. S. Parmuk and J. W. Westwater, University of Illinois, Urbana, Illinois.)

In the Future . . .

. . . **Queen's University** plans a post-graduate course for chemical engineers from industry (May 16-May 28, Kingston, Ont.) . . . AIChE Northern California Section is sponsoring a waste disposal symposium (June 17, Berkeley) . . . Technological Institute of Monterrey will sponsor a short course in instrumentation for Mexican industries (July 20-22, Monterrey, Mexico) . . . Materials Handling Exposition will have the

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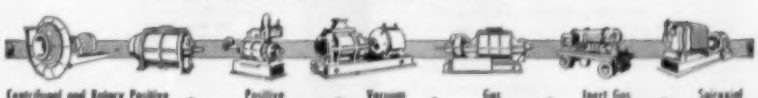

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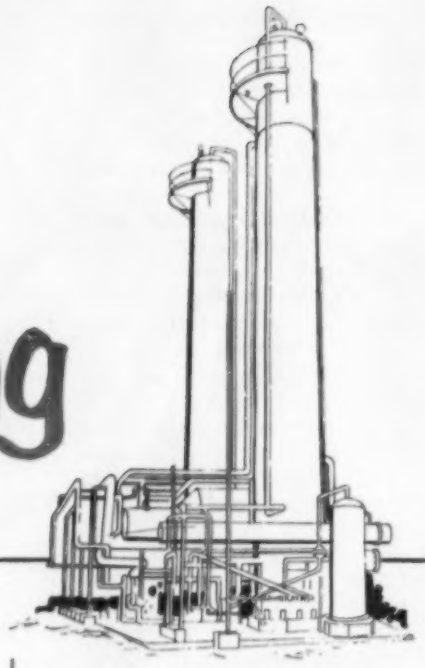

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Who's Meeting . . .

"concept of obsolescense" as its theme this year (May 16-20, Chicago) . . .

MEETINGS CALENDAR

MAY	
14-22	World Wide Chemical Plant and Equipment Exposition and Congress, Frankfurt, Germany.
16-18	American Petroleum Institute (Division of Marketing, Lubrication Committee), The Greenbrier, White Sulphur Springs, W. Va.
16-20	National Fire Protection Association, Netherlands Plaza Hotel, Cincinnati, Ohio.
16-20	National Materials Handling Exposition, International Amphitheater, Chicago.
18	Chemical Market Research Association (Annual Business Meeting), Hotel Plaza, New York.
23-27	Conference on Mass Spectrometry, Sponsored by American Society for Testing Materials Committee E-14, Mark Hopkins Hotel, San Francisco.
26-27	Western Petroleum Refiners Association (Regional Technical-Industrial Relations Meeting), Settles Hotel, Big Spring, Texas.
30-June 1	Chemical Institute of Canada (38th Annual Conference and Exhibition), Quebec City, Canada.
JUNE	
1- 3	Short Course in Gas Technology, Sponsored by Texas College of Arts & Industries, Kingsville, Tex.
5- 9	Canadian Gas Association (Annual Meeting), Sheraton Broeck Hotel, Niagara Falls, Ont., Canada.
6-15	Fourth World Petroleum Congress, Rome, Italy.
9-10	Natural Gas & Petroleum Association of Canada, Royal Connaught, Hamilton, Ont., Canada.
12-17	Society of Automotive Engineers Golden Anniversary Summer Meeting, Chalfonte Haddon Hall, Atlantic City, N.J.
20-23	American Society of Mechanical Engineers (Semi-Annual Meeting), Statler Hotel, Boston, Mass.
23-24	Western Petroleum Refiners Association (Regional Technical-Industrial Relations Meeting), Broadview Hotel, Wichita, Kansas.
26-July 1	American Society for Testing Materials Committee D-2, Petroleum Products and Lubricants, Chalfonte Haddon Hall, Atlantic City, N.J.
SEPT.	
14-16	National Petroleum Association (Annual Meeting), Traymore Hotel, Atlantic City, N.J.
22-23	Western Petroleum Refiners Association (Regional Technical-Industrial Relations Meeting), Hotel Henning, Casper, Wyo.
22-23	Mid-Continental Oil & Gas Association, Louisiana-Arkansas Division (Annual Meeting), Roosevelt Hotel, New Orleans.
25-28	American Society of Mechanical Engineers (1955 Petroleum Mechanical Engineering Conference), Roosevelt Hotel, New Orleans.
25-28	American Institute of Chemical Engineers, Lake Placid Club, Lake Placid, N.Y.
OCT.	
2- 6	American Society for Testing Materials Committee D-2, Petroleum Products and Lubricants, Statler Hotel, Washington, D.C.
3- 7	American Institute of Electrical Engineers (Fall General Meeting), Morrison Hotel, Chicago.
13-14	California Natural Gasoline Association (Annual Fall Meeting), Ambassador Hotel, Los Angeles.
17-19	American Gas Association (Annual Convention), Los Angeles.
18-22	National Safety Congress & Exposition, Sponsored by National Safety Council, Chicago.
20-21	Western Petroleum Refiners Association (Regional Technical-Industrial Relations Meeting, Garrett Hotel, El Dorado, Ark.
31-Nov. 2	National Lubricating Grease Institute (Annual Meeting), Edgewater Beach Hotel, Chicago.

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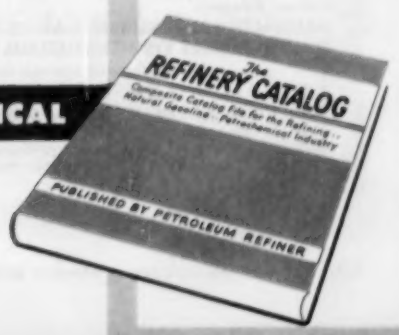
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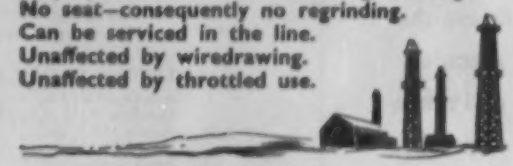

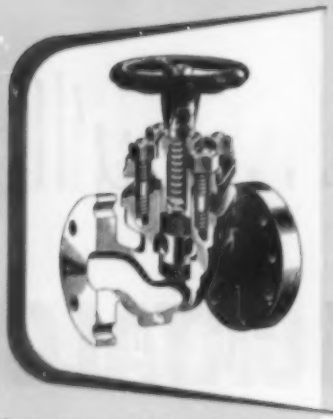

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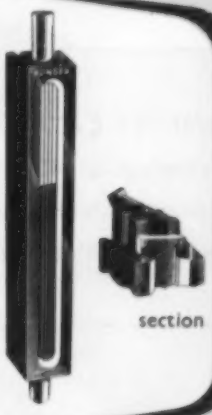

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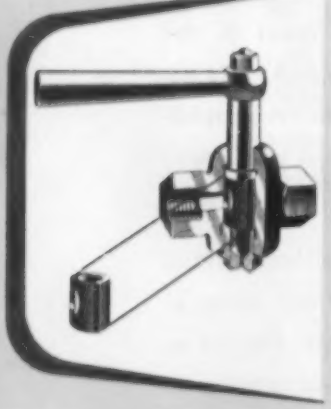

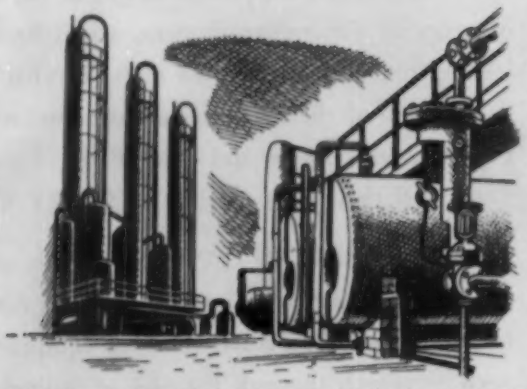

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Graham Cone Humphrey Wilcoxson Van Zee Dixon Stockdale Baker Eskridge

Walter K. Graham, who formerly was district manager for A. O. Smith Corporation at Atlanta, Ga., is now manager of oil field sales for **Harnischfeger Corporation.** During the Korean War, he was in charge of material production for the Petroleum Administration for Defense.

Charles A. Cone, with **Dresser Engineering Corporation** since 1935, has been moved up to vice president of the Tulsa firm.

F. L. Humphrey, Jr., has been promoted to district manager for **Elliott Company's** Atlanta, Ga., territory. Assistant district manager since last year, he joined the company in 1928.

L. S. Wilcoxson, who has been vice president in charge of research for **The Babcock & Wilcox Company** since 1945, has been elected vice president in charge of the company's Boiler division.

B. G. Van Zee, chief engineer for the Automotive Engineering division of **Minneapolis-Moline Company,** is the newly-elected president of the Internal Combustion Engine Institute, an organization representing manufacturers of high-speed gasoline and diesel engines.

Donald E. Dixon, who was manager of compressor sales at **The Cooper-Bessemer Corporation's** Mount Vernon, Ohio, plant, is now field engineer at the company's district office in Tulsa.

H. L. Stockdale has been elected president of **Insul-Mastic Corporation of America.** At one time manager of the company's Houston branch, Stockdale succeeds Clifford Off.

Robert E. Baker, vice president of **The Airetool Manufacturing Company,** has been named as co-director of a new Netherlands plant the company is building near Rotterdam.

Wade A. Eskridge, who recently joined **Clark Equipment Company,** has been selected to manage a new field office the company's Automotive division has opened in Tulsa. The new territory covers Oklahoma, Texas, Kansas, Colorado, Missouri, Arkansas, Louisiana and parts of New Mexico and Tennessee.

Krell Sewell Pauly Loomis Reinking Gamble Riggs Devin Brna

Fred K. Krell has been appointed as assistant sales manager for **Ladish Company's** Fittings division.

J. B. Sewell, general manager of **The Garlock Packing Company,** has moved up to vice president. He is a former vice president of the Canadian affiliate, The Garlock Packing Company of Canada, Ltd.

Melvin W. Pauly, who was general sales manager for **The Lunkenheimer Company,** has been elevated to vice president in charge of sales.

J. H. Loomis has been appointed manager of **Worthington Corporation's** St. Louis office. Previously, he was a salesman and compressor specialist at the district office in Chicago.

Arthur F. Reinking, formerly manager of Worthington Corporation's turbine sales, heads its new Steam Turbine division, formed in a merger of the Steam Turbine Sales division and the Wellsville Works.

Cyril P. Gamble, who was vice president and secretary of United Engineers and Constructors, Inc., is now controller for **Quaker Rubber Corporation,** division of H. K. Porter Company, Inc. Both firms are in Philadelphia.

Orval W. Riggs, for the past two years sales manager for **The Hays Corporation,** has been elected vice president in charge of sales.

Fletcher Devin, The Cooper-Bessemer Corporation's district sales manager for Ohio, Kentucky, Michigan, West Virginia and Tennessee, has been promoted to vice president.

Paul Brna has been appointed engineering representative for **Rhodia, Inc.,** in its Mid-Continent area. Formerly, he was associated with Roubechez, Inc.

Atlas Powder to Award Eight $1000 Scholarships

Atlas Powder Company will award eight $1000 college scholarships again this year. The grants will go to students who will be seniors during the 1955-56 college year, majoring in chemistry or any branch of engineering.

Last year, the first year the scholarships were offered, more than 160 applicants were screened before eight winners were selected. The program, in which 38 colleges and universities have been invited to participate, will be administered by a committee under Dr. Thomas Kennedy, the company's director of industrial and public relations.

Kaiser Names Engineer To California Post

William H. Kinney is the new resident metallurgical engineer for Kaiser Steel Corporation at Oakland, Calif. Kinney joined Kaiser Steel in 1948 and since then, has held various metallurgical posts in the company's mill at Fontana, Calif.

Wolverine Picks Representative

Wolverine Tube, Division of Calumet & Hecla, Inc., has designated E. C. Humphrey, Jr. as its sales representative in the upper peninsula of Michigan, northwestern Wisconsin, Minnesota and North and

Suppliers . . .

South Dakota. Formerly a representative for American Machine & Metals Company, Humphrey will headquarter in Wolverine's Minneapolis, Minn., office.

Barber-Colman Names Representatives for Texas

Barber-Colman Company has selected two Texas firms as exclusive representatives for the sale of Wheelco industrial instruments in their areas. R. H. Wittbold will handle instrument sales in the Houston area, while Swieco, Inc., will represent the Wheelco line in the territory around Fort Worth.

Vice President Elected

Philip H. Smith has been elected vice president and sales engineer for the Nooter Corporation. The St. Louis company is a fabricator of plate, tanks and vessels for the chemical and petroleum industries.

Canadian Firm Organizes New Engineering Division

Catalytic Construction of Canada, Ltd., has formed a new engineering division at its headquarters in Sarnia, Ont. Named as chief engineer to the new division is Richard P. Schorman, associated with the Catalytic organization since 1951.

The new division will take part in Canadian development of chemical, metallurgical, petroleum and oil refining industries.

Names Representative For New England

The Standard Tube Company has designated Ross Saylor as its carbon and stainless tubing representative in New England. Saylor will headquarter in West Hartford, Conn. Tubing and pipe sales in New York City and northern New Jersey will be handled by W. A. Taussig.

Stone & Webster Official Marks 62 Years with Company

Leonard B. Buchanan, an executive of Stone & Webster Service Corporation, was honored recently on his 82nd birthday with a dinner attended by representatives of Stone & Webster, Inc., and affiliated companies.

Buchanan, who remains active in the business, was graduated from M. I. T. in 1893 with a degree in electrical engineering. He went to work for the company that fall.

Enters Laminates Field

Eastern Industries, Inc., is entering the plastic laminates field, with the formation of a new affiliate, New England Laminates Company. The new company will manufacture plastic laminates for the electrical and electronic industries.

Timken Increases Output

The Timken Roller Bearing Company's Steel division has put eight of its nine electric furnaces into operation. With the firing of the eighth furnace, the company's Steel division moved into production at 95 percent of its rated capacity.

Childers Picks Agents For Western States

Childers Manufacturing Company has named five firms in different parts of the country to serve as engineering consultants and sales representatives. Childers, a Houston company, produces a line of weatherproof covering for insulations.

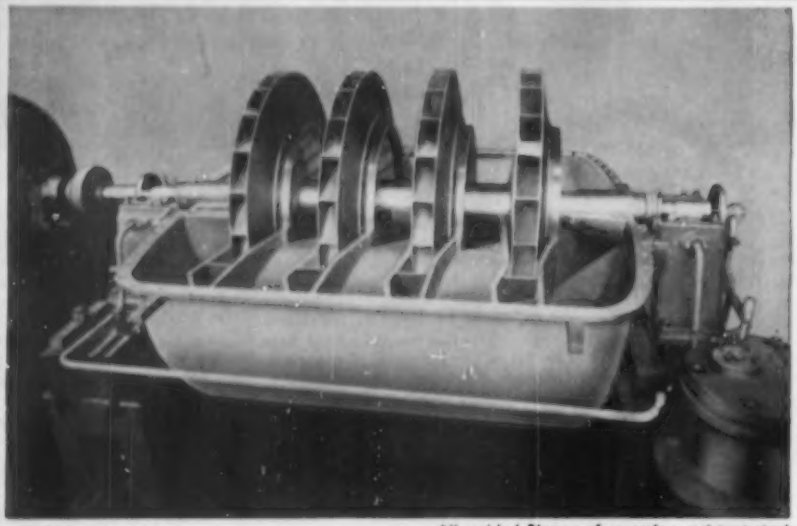
John P. Dobbins Company, Tulsa, was picked to cover Oklahoma; D. M. Allen Company, Kansas City, will serve Kansas and western Missouri; Vernon Hines of the Thermo Tech Products Company in Denver, will make calls in Colorado, southeast Wyoming and western Nebraska; Pace-Turpin Company, Salt Lake City, will service Utah, southern Idaho and western Wyoming, and Fred G. Greavers Company, Seattle, will cover Washington, Oregon, British Columbia and northern Idaho.

H. K. Porter President To Receive Market Award

Thomas Mellon Evans, president of H. K. Porter Company, Inc., has been selected to receive the 11th annual Parlin Memorial Award for "outstanding contributions to the field of marketing." The award will be presented by Philadelphia's chapter of the American Marketing Association.

Crane Company Marks Centennial Year

Crane Company is entering its centennial year. Now one of the world's largest manufacturers of valves and fittings, the company had its beginning July 4, 1855, when a 23-year-old foundryman opened a one-man, self-built frame shop in Chicago, a city of 75,000. Originally known as the



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The extensive fabrication program of our Mechanical Engineering Division comprises among others

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ALCOA ALUMINUM

Heat Exchanger Tubes are used by The Pure Oil Company at the Van, Texas, Gasoline Plant in

De-ethanizer Condenser
handling methane, trace propane, ethane

Rich Oil-Lean Oil Exchangers
handling rich oil with propane, butane, isobutane, gasoline

First Stage Compressor Aftercoolers
handling intake natural gas

Second Stage Compressor Aftercoolers
handling intake natural gas

Depropanizer Preheater
handling iso and normal butane, propane, gasoline

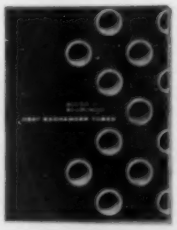
Absorber Intercooler
handling rich oil

Recompressor Aftercoolers
handling natural gas that is rich in propane, butane, gasoline

Residue Gas Coolers
handling cooling water

ALCOA Aluminum Heat Exchanger Tubes in the common sizes cost less than seamless tubes of other common materials. For example, seamless ALCOA Aluminum tubes cost two-thirds as much as seamless mild steel—one-half as much as Admiralty brass—one-third to one-fifth as much as cupronickel or stainless steel.

ALCOA Aluminum's natural resistance to attack by many corrosive materials results in longer life and lower maintenance costs. It prevents discoloration and contamination of products that require water whiteness. Tubes with alclad coatings offer even greater protection against perforation from pitting or localized corrosion.



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For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

R. T. Crane Brass & Bell Foundry, the company first produced brass couplings and copper tips for lighting rods. Today, it manufactures thousands of products.

New Analytical Controls Designed into Chemical Plant

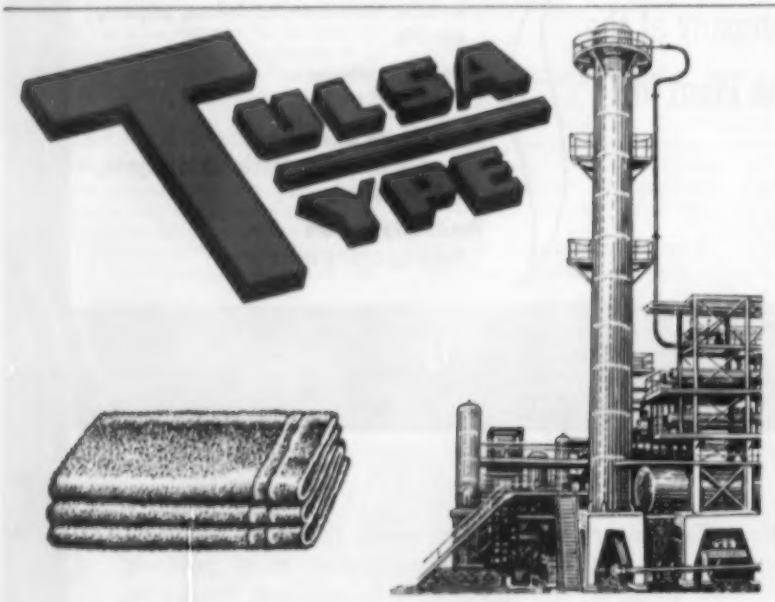
A new $50-million American Cyanamid Company petrochemical plant at Fortier, La., is successfully using continuous infrared analyser to control purity and output of its process stream. These analytical facilities, produced by Perkin-Elmer Corporation, mark the first time such continuous analytical controls have been designed into the process stream of a chemical plant this size.

Johns-Manville Elects New Vice President

Edward D. Flavin has been elected vice president of Johns-Manville Sales Corporation and manager of special industries. Formerly assistant manager of the Special Industries department of the Industrial Products division, he succeeds L. A. Baldwin, who retired after 35 years with the company.

Union Opens New Building

Union Asbestos & Rubber Company now has its Product division sales staff headquartered in a new building adjacent to the Bloomington, Ill., plant. The new building, recently completed after work started last fall, also houses the division's Product Control and Specifications departments.



TOWELS, TOWERS and TRADEMARKS

A well-known trademark — the signature of a product's maker — is as important on a giant steel bubble tower as it is on your best guest towels. And TULSA TYPE, for 30 years the trademark of FLINT STEEL refinery and natural gasoline plant equipment, has become one of the best known labels in the industry.

The TULSA TYPE name is your assurance of sound engineering and precision workmanship on every piece of equipment. All manufacturing processes used in the fabrication of TULSA TYPE equipment comply with API-ASME and ASME industry codes. Look for TULSA TYPE when you need steel plate fabrication for petroleum or petrochemical plants.

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Write for our General Catalog

FLINT STEEL CORPORATION
TULSA, OKLAHOMA

Joy Appoints Manager For New England Sales

Joy Manufacturing Company has chosen Donald L. Archibald as manager of its New England district sales office in Boston. With the Joy organization since 1940, Archibald will be transferred from a post in St. Louis.

Hercules Consultant Named to Defense Job

Hercules Powder Company has granted its smokeless powder consultant a year's leave of absence to accept an appointment as Deputy Assistant Secretary of the Army. Henry N. Marsh, consultant to the company's Explosives department at Wilmington, Del., and an advisor on civilian and military matters, will take civilian control of the Army's logistics, research and development.

Koppers Picks Vice President

F. L. Byrom, who was manager of Tar Products division operations for Koppers Company, Inc., has been promoted to divisional vice president and assistant manager of the Tar Products division. He succeeds R. R. Holmes, who recently was made vice president and general manager of the division following the election of Fred C. Foy as president of the company.

Names Representative

Sarco Company, Inc., has designated Hoffman & Hoffman Company as its sales representative in North and South Carolina. Sales offices will be maintained in Greensboro and Raleigh, N. C., and Columbia, S. C.

Centralizes Operations

Sandvik Steel, Inc., is building a new plant in Fair Lawn, N. J., which will consolidate operations of the company and its four divisions in one location. The plant is expected to be ready for occupancy this spring.

Allis-Chalmers President Dies

W. A. Roberts, president of Allis-Chalmers Manufacturing Company since 1951, died suddenly April 12, following a heart attack. He was 57 years old.

Opens Alberta Branch

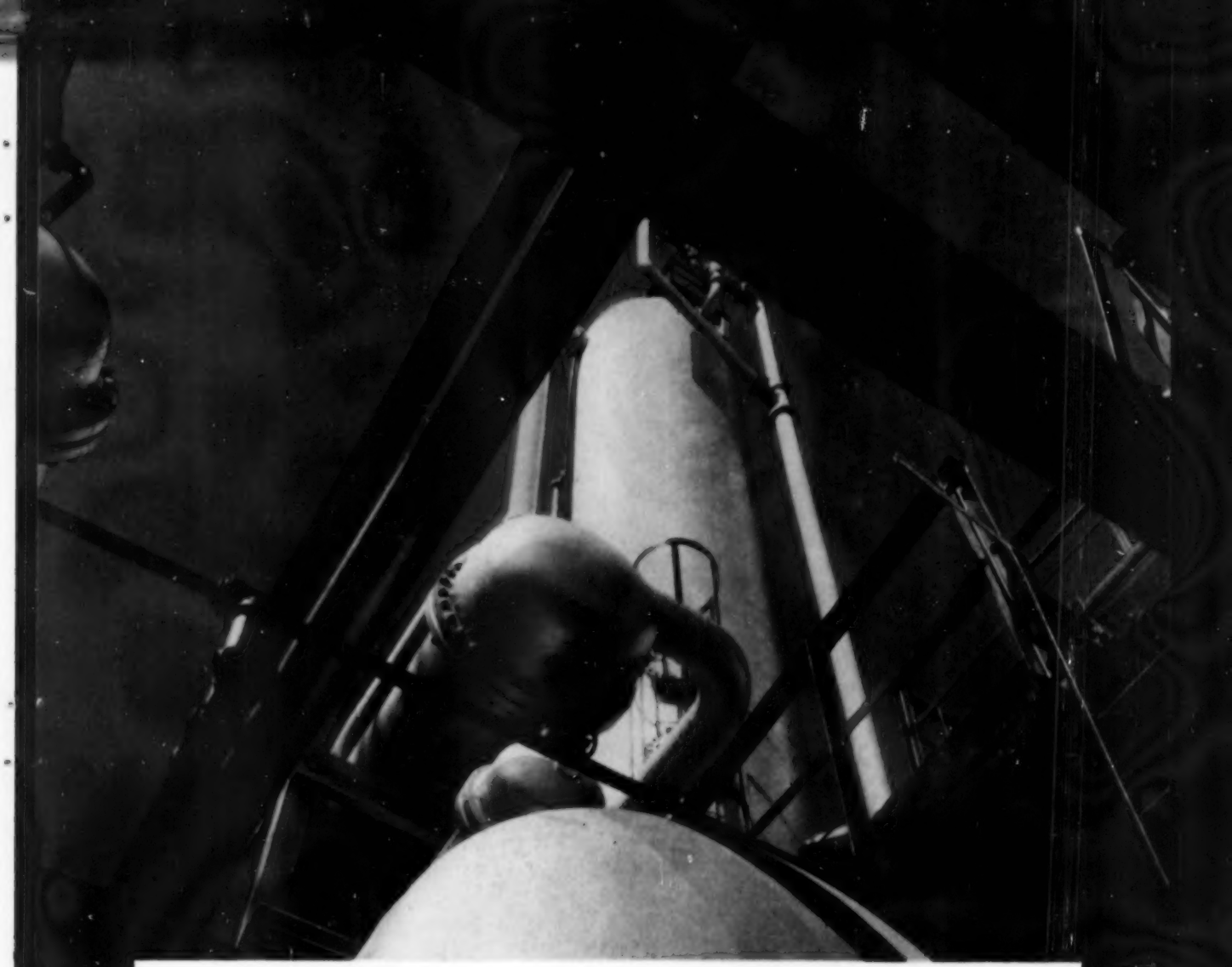
Minneapolis-Honeywell Regulator Company, Ltd., has opened a branch at Calgary, Albt. Present at the ceremonies opening a new office and warehouse was Tom McDonald, executive vice president of the parent company.

Houdry Earnings Gain

Houdry Process Corporation and its subsidiaries reported consolidated net earning, after taxes, amounting to $393,508 in 1954, as against $325,419 in 1953. Earnings climbed to $1.20 a share, as compared

Switch Plant Opens in Iowa

Micro Switch, a division of Minneapolis-Honeywell Regulator Company, has opened a new assembly plant at Independence, Iowa. The plant, which will produce mercury switches and snap-acting switch products, is expected to manufacture other products also as tooling becomes available.



helpful refinery service that pays for itself!

TRETOLITE DESALTING

is used to desalt over one and one-half million barrels of crude oil daily. Salt removals are in the range of 95 to 100%, with chemical costs averaging around 2 mills per barrel. Regardless of the capacity requirement, Tretolite desalting offers a simple, flexible and economical answer.

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Water Clarification Compounds
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KONTOL Corrosion Inhibitors

protect internal metal surfaces by forming a protective mono-molecular film. They also offer excellent detergent properties which assure the advantages of operations with clean units. Kontol inhibitors are available in numerous formulas, suitable for use in the various corrosive environments encountered in the refinery.

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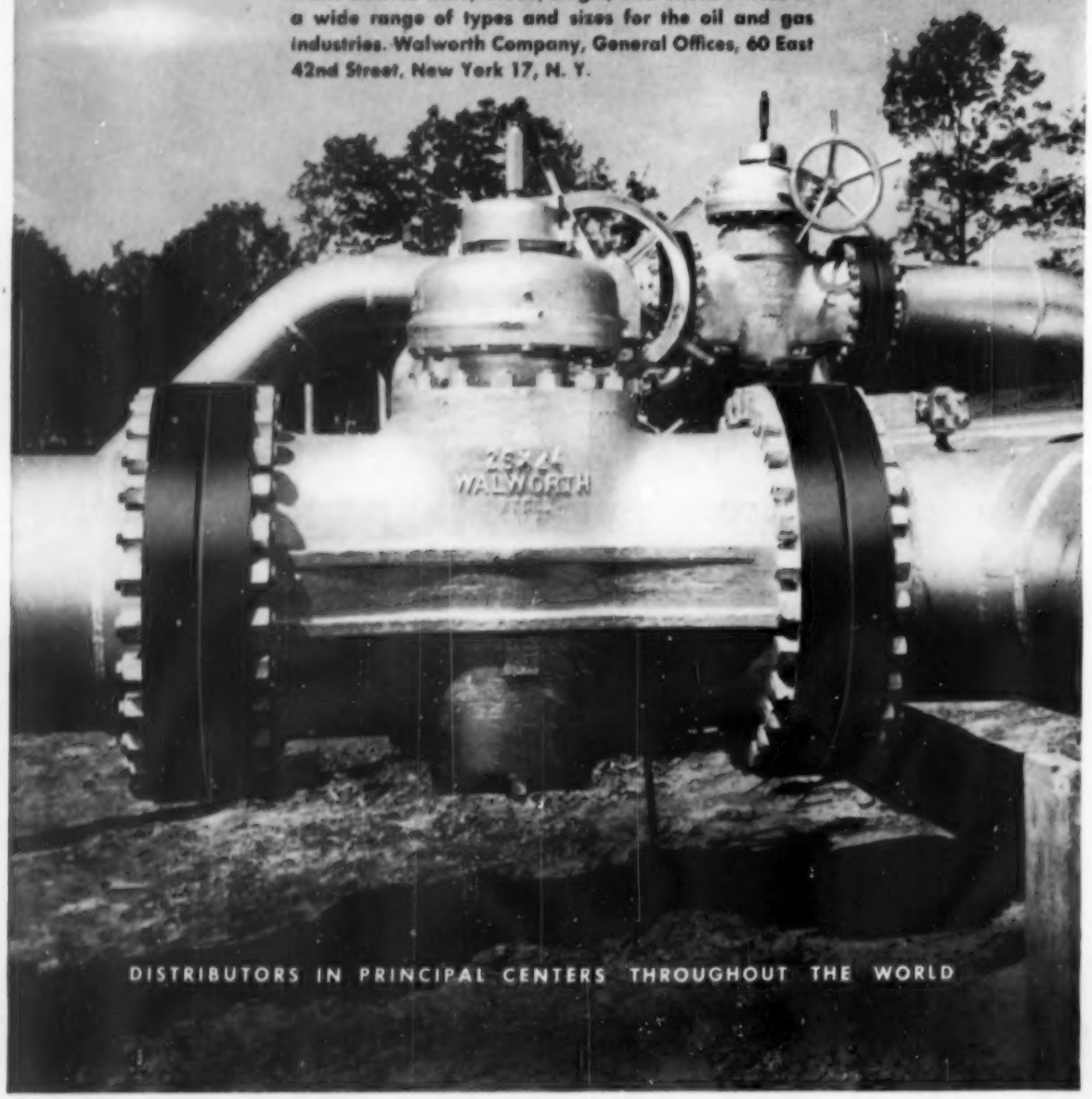
Two Walworth Cast Steel Lubricated Plug Valves in use on the main line of a southeastern gas pipeline.

In addition to Lubricated Plug Valves, Walworth manufactures Gate, Globe, Angle, and Check Valves in a wide range of types and sizes for the oil and gas industries. Walworth Company, General Offices, 60 East 42nd Street, New York 17, N. Y.



DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

Byron Jackson Promotes Four—

Byron Jackson Company has elected four new vice presidents. They are (left to right) Evan H. Sweet, a member of the Legal department since 1945, now assigned as the company's counsel; Norman D. Jesse, manager of the Pump division's Eastern branch since 1939, placed in charge of all sales and branches for the division; Garth F. Nicolson, formerly general manager of the Oil Tool division, moved up to vice president in charge of the division, and Ross Barnett, public relations director, given responsibility for all public relations, advertising and market research.

to 99 cents for the previous year.

Catalytic Construction Company, a wholly-owned subsidiary, hit the highest earnings in its history, up 135 percent over the year before. The subsidiary's current work under contract was reported at more than $16 million, representing construction in the petrochemical and chemical industries as well as in refinery construction.

Unarco Breaks Ground To Expand Texas Plant

Ground has been broken for a 50,000-square-foot addition to Union Asbestos & Rubber Company's new plant at Tyler, Texas. The addition will double the size of the existing plant, which Unarco took over last fall.

The company moved to Tyler from McGregor, Texas, after the government took over Unarco's McGregor factory last fall. Production was started at the Tyler plant early this year.

Davison Chemical Builds New Maryland Plant

Plans for the construction of a new $4-million plant for the manufacture of catalysts at Curtis Bay, Md., are being formed by Davison Chemical Company, division of W. R. Grace & Company.

The plant, part of the division's modernization and expansion of its catalysts facilities, will manufacture the microspheroidal form of synthetic catalyst. It will replace an existing plant which produces the older form of catalyst.

Conoflow Representative Appointed for Alabama

George S. Edwards, manufacturers' representative in Birmingham, Ala., has been given charge of sales for Cono Controls in Alabama. Formerly a design engineer and sales engineer in the Birmingham area, Edwards organized his own business in 1953 as a representative of manufacturers in the industrial process control.

Laclede-Christy Appoints District Works Manager

L. L. Cook, general superintendent of glass industry refractories and refractory specialties, has been promoted to district works manager for Laclede-Christy Company, division of H. K. Porter Company, Inc. Cook has been a member of the company's operations division since 1940.

Suppliers . . .

Borax Headquarters District in Kansas City

Pacific Coast Borax Company, division of Borax Consolidated, Ltd., has opened a new district sales office in Kansas City, Mo. The office will serve three company divisions: Package, Agricultural Sales and Industrial Sales.

Howard B. Cain is Package department sales manager for Kansas City, and F. M. Dosch, assisted by J. G. Neckerman, will be in charge of the Agricultural Sales division. Jack Loesel is handling industrial sales in the area.

Stauffer Chemical Expands Bayonne Insecticide Plant

Stauffer Chemical Company has completed an expansion program at its insecticide plant at Bayonne, N. J. The program includes the installation of additional units to increase the air milling capacity of the plant as well as a new unit to form liquid insecticides.

Ansul Chemical Sets Dates For Firefighting School

Ansul Chemical Company's Industrial firefighting school at Marinette, Wis., has scheduled 12 different three-day classes for the spring and summer of 1955. The first class is due to begin May 23.

Courses are open to industrial plant safety personnel, fire marshals, municipal

CORTROL C

CORROSION CONTROL IN RE-CIRCULATED COOLING WATER

Effective
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Inexpensive
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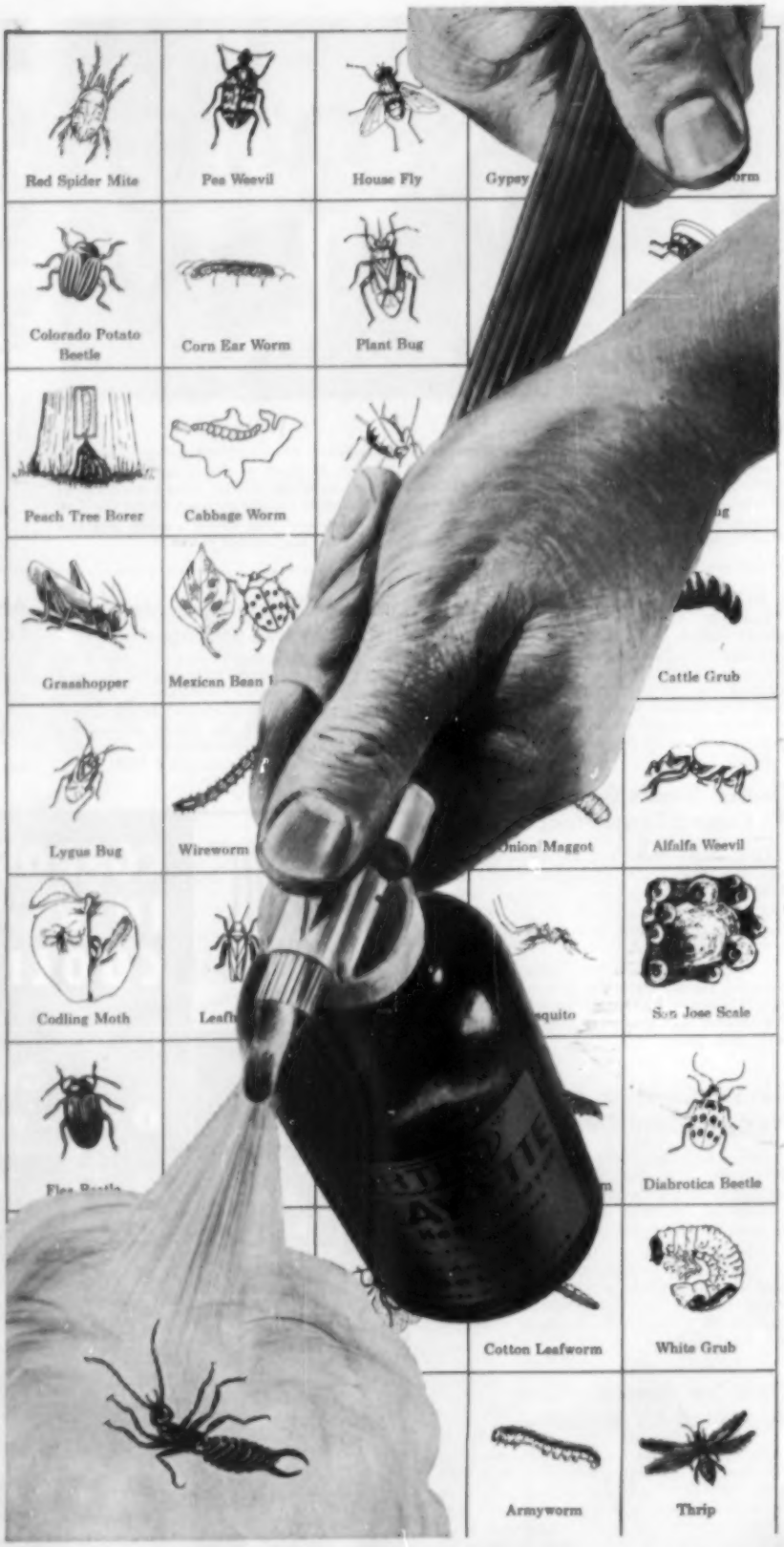
There's not enough food for you and the bugs

As any backyard gardener knows, you have a fight on your hands from the moment you turn over your first spadeful of earth. At every step, fungus growths, weeds, and insects that chew, insects that suck are waiting to destroy your lawns, trees, plants, flowers. It is a disheartening struggle for Greenthumbers . . . a round-the-clock fight for commercial farmers.

Fortunately, there's a growing list of weapons we now can wield in the battle against bugs. Some of the most effective have been developed in the laboratories of California Spray-Chemical Corporation, a Standard Oil Company of California subsidiary. In 1907, we brought out the first basic lead arsenate to stop the codling moth, a rampaging fruit crop destroyer; later, the invention of new-type summer and dormant oil sprays safely checked scale and other insects.

Other Standard research achievements have been chemicals to kill aphis, mites, thrips, and similar sucking insects . . . dusts to destroy fungus diseases like rust, blight, mildew...sprays and dusts custom-made to knock out such public enemies as the devastating grasshopper, boll weevil, hornworm. Other pest-killers boost milk production from our dairy herds, help beef cattle fatten faster.

One good reason you live in the world's best-fed nation is because insect invaders have been held back on our farms, ranches, and orchards, thanks in part to Standard's constant hunt for new ways to make petroleum do more things for you.



STANDARD OIL COMPANY OF CALIFORNIA *plans ahead to serve you better*

and military firefighters and other interested people. Registration is limited to 25 people in each class.

Further information will be furnished by writing Fire School Director, Ansul Chemical Company, Marinette.

Arizona Chemical Picks Chicago Representative

Robert T. Schoepflin has been appointed Midwest sales representative for Arizona Chemical Company. He will be located in the Chicago office of American Cyanamid Company, which jointly owns Arizona Chemical with International Paper Company.

Schoepflin, a salesman with Cyanamid since 1953, will service industrial users of sulfate turpentine derivatives and tall oil derivatives.

Process Engineer Joins Refinery-Building Firm

David G. Reynolds has joined the staff of Ehrhart & Arthur, Inc., engineers and contractors, as chief process engineer. He will headquarter in the company's Los Angeles office.

Reynolds

A veteran of 15 years' experience with process designers and engineering contractors, Reynolds takes over a position of directing all the process and design work for refinery and chemical units built by the company.

Tubular Products Names Plant Superintendent

Tubular Products division of The Babcock & Wilcox Company has appointed George W. Kross, Jr., as superintendent of its plant at Alliance, Ohio. Carl J. Stoops was appointed as assistant superintendent.

Assistant superintendent since 1953, Kross started with the company as a student engineer at its Beaver Falls plant in 1947. Later he worked on special projects at the Keystone plant.

Stoops started with the company at Beaver Falls as a production expeditor in 1939. In 1943, he was transferred to the Alliance operation where he was manager of mill scheduling traffic and steel inventories.

Quaker Rubber Appoints Packing Sales Manager

A. J. Lamond has been appointed manager of packing sales for Quaker Rubber Corporation, a division of H. K. Porter Company, Inc. He will be responsible for coordinating factory and field activities for the company's sales staff. Lamond has 12 years experience with the Quaker organization.

De Laval Names Outlet

Industrial Agencies, Ltd., has been appointed the exclusive representative for De Laval Steam Turbine Company, Trenton, N. J., in the Islands of Trinidad and Tobago.

Suppliers . . .

Union Division Selects Assistant Sales Manager

Earl T. Plummer has been promoted to assistant general sales manager of Union Asbestos & Rubber Company's Fibrous Products division. He formerly was assigned to the company's offices in Houston.

Plummer

Plummer joined Unarco in 1950 as a sales representative for the Fibrous Products division in San Francisco. He will headquarter in Bloomington, Ill.

Company Changes:

Gordon H. Perrin, plant manager for **Shippers' Car Line Corporation** at Smackover, Ark., will succeed **H. H. Theisen** as sales manager of the company's Mid-Continent district, headquartered in Tulsa. Theisen has retired after 25 years with the company . . . **R. E. Mahany** is the new manager of **A. Y. McDonald Manufacturing Company's** branch office at Burlington, Iowa. Formerly branch manager at Columbia, Mo., he will be replaced by **M. G. Toft,** who was assistant to the manager at Kansas City . . . **Robert E. Bader** has been elected executive vice president of **The Emil Greiner Company.** He also will continue as treasurer . . . **J. N. Rogers** is a new district salesman assigned by the Tubular Products division of **The Babcock & Wilcox Company** to its St. Louis, Mo., office. **William L. Wolfe** has been elected vice president in charge of sales for **Jones & Laughlin Steel Corporation.** He was promoted from assistant to the vice president . . . **John W. Miller,** who has been production planning superintendent for **Kaiser Steel Corporation,** is the company's new manager of product planning . . . **Albert W. Gudal** is the new assistant purchasing agent for **Lukens Steel Company.** Formerly supervisor of planning and controls, he also becomes a member of the company's Management Council . . . **J. Bruce Rowell** has been appointed to a newly-created post of assistant treasurer for Dow export companies, **Dow Chemical International, Ltd.,** Dow Chemical Inter-American, Ltd., and Dow Export Company.

William H. Ruth, Jr., has been appointed director of **Atlas Powder Company's** Ordnance Material division in Wilmington, Del. He will be succeeded as general manager of Volunteer Ordnance Works in Chattanooga, Tenn., by **Harold B. Palmer,** formerly assistant director of sales for the Atlas Explosives department . . . **John H. Elleman** is director of a new Coordination department recently set up by Solvay Process division, **Allied Chemical & Dye Corporation.** Formerly director of sales, he is being replaced by **Arthur Phillips, Jr.,** who had served as his assistant . . . **Earl Englert,** until recently a sales engineer in **The Girdler Company's** New York office, now heads catalyst sales for the company's Gas Processes division.

T. M. Lamberth, Jr., has been promoted to manager of **The Cooper-Bessemer Cor-**

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QUICKLY, PERMANENTLY
ANY PRESSURE — ANY TEMPERATURE

SKINNER-SEAL EMERGENCY PIPE CLAMP
for pinhole or corrosion leaks.

SKINNER-SEAL PIPE LINE CLAMP for
long splits and bad corrosion leaks.

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ERNST
SIGHT FLOW INDICATORS
"See What Goes On Inside"

For insertion into pipe
FOR EVERY APPLICATION
BRONZE, IRON, STEEL, STAINLESS STEEL

FIG. 29
Cylinder with Impeller

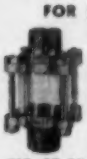

FIG. 17-28
Cylinder

FIG. 218
Flanged

FIG. E-57
Double Window

FIG. 212
Visibility Welding Neck or Screw

FIG. E-811
Flapper

FIG. E-1810
Rotating Wheel Type

All sizes up to 6" Send for Catalog

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LIVINGSTON, N. J.

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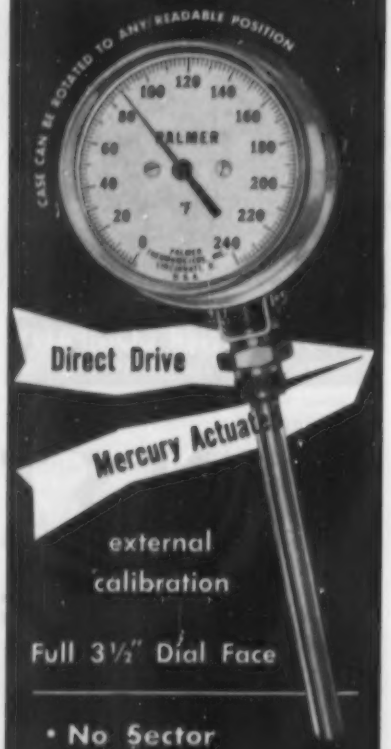

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Mfrs. of Industrial Laboratory Recording and Dial Thermometers

Suppliers . . .

poration's Shreveport, La., branch. Formerly assigned to the company's engineering and manufacturing facilities at Mount Vernon, Ohio, Lamberth succeeds **A. K. De France**, who recently died . . . **Ralph E. Hoover** has joined **The Standard Tube Company** as assistant to the president. Other new assignments in the organization include **Lawrence B. Boensch**, named a district sales manager, and **Harry E. Colwell**, who will be chief inspection and process engineer . . . **W. F. Munnikhuysen** has been elected chairman and **Fred C. Foy** was named as president of **Koppers Company, Inc.** They fill the vacancies created by the death of **General Brehon Somervell**, who held both positions.

Fluid Coke Scores Success As Fuel at Kaiser Plant

Successful use of fluid petroleum coke as a fuel in an industrial plant operating at full capacity was announced today by Kaiser Engineers division of Henry J. Kaiser Company.

The recent test was made during kiln firing at the Permanente Cement Company's plant at Permanente, Calif. Normal production operations were neither interrupted nor reduced when the fluid coke was injected into the fuel system.

The coke-producing process is a recent development of Esso Research & Engineering Company. The material for the test was supplied to Kaiser Engineers by Carter Oil Company's new fluid coking units at Billings, Mont.

Tellepsen Assigns Development Engineer

Howard K. McLaughlin, until recently development engineer with Naugatuck Chemical division of U. S. Rubber Company, has been named assistant chief engineer for Tellepsen Petro-Chem Contractors, a Houston, Texas, division of Tellepsen Construction Company.

McLaughlin

Prior to his association with Naugatuck in 1951, McLaughlin worked four years in design and research for Commercial Solvents Corporation.

Arizona Chemical Selects Zeni as Sales Manager

Henry C. Zeni was named Sales Manager of Arizona Chemical Company. Zeni, whose appointment follows a 30-year sales career in the chemical industry, has been in a sales direction capacity at Arizona since 1952. The firm is jointly owned by American Cyanamid Company and International Paper Company.

Forms Market Group

Koppers Company, Inc., has formed a company-wide Marketing department under Ralph Winslow, vice president. Taking over functions now handled by the Central Staff Sales and Public Relations depart-

The Chemistry of Petrochemical Reactions

By LEWIS F. HATCH, Ph.D.

Professor of Chemistry, University of Texas

This 192-page, completely indexed volume is the only thorough and exhaustive treatise on the basic chemistry of reactions and processing of those products and intermediates popularly classified as petrochemicals.

A completely contemporary study, this book is an immediate and valuable reference for anyone engaged in either the chemical or refining industry.

In addition to the technical data, valuable commentaries on end use and market of many significant chemicals are presented in such manner as to make this book a practical working manual.

This new book is a complete presentation of the material originally published as an 18-part series in *Petroleum Refiner*. Revised to date by Dr. Hatch, these current and authoritative studies on petrochemicals are now indexed for easy reference by subjects or products.

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New Houdry Iso-Plus Process Reforms Low-Octane Naphthas Into 100-Octane Plus Gasoline

The new Houdry Iso-Plus Process reforms run-of-the-refinery low-octane naphthas into gasolines with octane ratings as high as 108-octane F-1 clear.

Conversion rates are extremely high. Variations of the Iso-Plus Process yield from 86% to 91% of naphtha charge stock into 100 octane gasoline. Up to 82% of the charge stock can be converted to 108 F-1 clear octane gasoline for blending with refinery pool gasolines of lower anti-knock ratings.

The development of Houdry Iso-Plus gives refiners a conclusive answer to the present high octane derby. With 300 h.p. automobile engines predicted for 1960, refiners are now planning their process facilities for the economical production of suitable fuels. Houdry Iso-Plus, already extensively tested in the pilot stage, can meet all high-octane requirements of the foreseeable future.

For further information, write to Houdry Process Corporation, 1528 Walnut Street, Philadelphia 2, Pennsylvania.

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"We needed a connection on a boiler feed water line (270°-760 psi) where water treating material could be introduced into the stream. I called TOPAZ and their sales engineer specified the equipment, supervised the preparation and made the tap for us. I got good service from TOPAZ without expensive down time or unnecessary risks."

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Suppliers . . .

ments," the new department will include sections for sales management, market and economic research, sales personnel development, sales promotion, advertising and public relations.

Emsco Vice President To Head Pump Company

A. H. Miller, vice president of Emsco Manufacturing Company, has been selected to serve also as general manager of Johnston Pump Company. His appointment comes as the result of Emsco's recent acquistion of the Johnston company.

Miller

Miller will continue as vice president of Emsco, as well as in his position as its secretary and treasurer. He will handle these duties in addition to his responsibilities as head of the Johnston organization.

Dow Superintendent Enters Saran Sales

Herbert D. Stuber, former superintendent of The Dow Chemical Company's Saran Rubber department, has opened an office in Indianapolis to represent Saran Lined Pipe Company in Indiana, Kentucky and parts of Ohio and Illinois.

Replacing Stuber as superintendent is Cyrus C. Perkins, a Dow employe since 1946, who served as engineering draftsman in the saran polymerization laboratory and as a development engineer in the Saran Rubber department. He is a co-inventor of equipment used in a phase of plastic polymerization.

Airco Chooses Manager For National Accounts

H. H. Reed, district manager for Air Reduction Sales Company's Metropolitan district in New York, has been appointed national accounts manager. He will be succeeded by O. M. Donohue, district sales manager.

Reed started with the company in 1923 and held various sales positions in the New York district before he became district manager in 1947. Donohue, who has been with the company since 1925, had been district sales manager since 1953.

Completing Laboratory

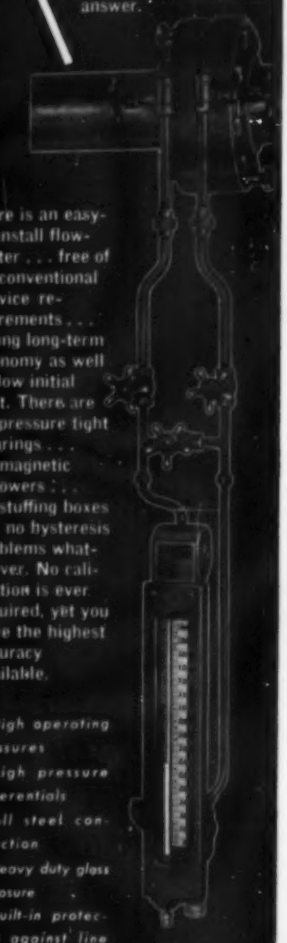
Rowan Controlling Company is completing an enlarged experimental laboratory at its Baltimore laboratory. The laboratory, to be furnished with electrical testing equipment, will be under the supervision of Lewis E. Woodward. He recently joined the company to take over its laboratory operations.

Names District Managers

Carbide & Carbon Chemicals Company has made two new assignments among its district sales managers. R. C. Boltz, for-

UNMATCHED ACCURACY
in direct flow indication

Wherever you seek simplicity and high accuracy in flow measurement at lowest cost, the Meriam "H" Meter is the well-known answer.



Here is an easy-to-install flowmeter . . . free of all conventional service requirements . . . giving long-term economy as well as low initial cost. There are no pressure tight bearings . . . no magnetic followers . . . no stuffing boxes . . . no hysteresis problems whatsoever. No calibration is ever required, yet you have the highest accuracy available.

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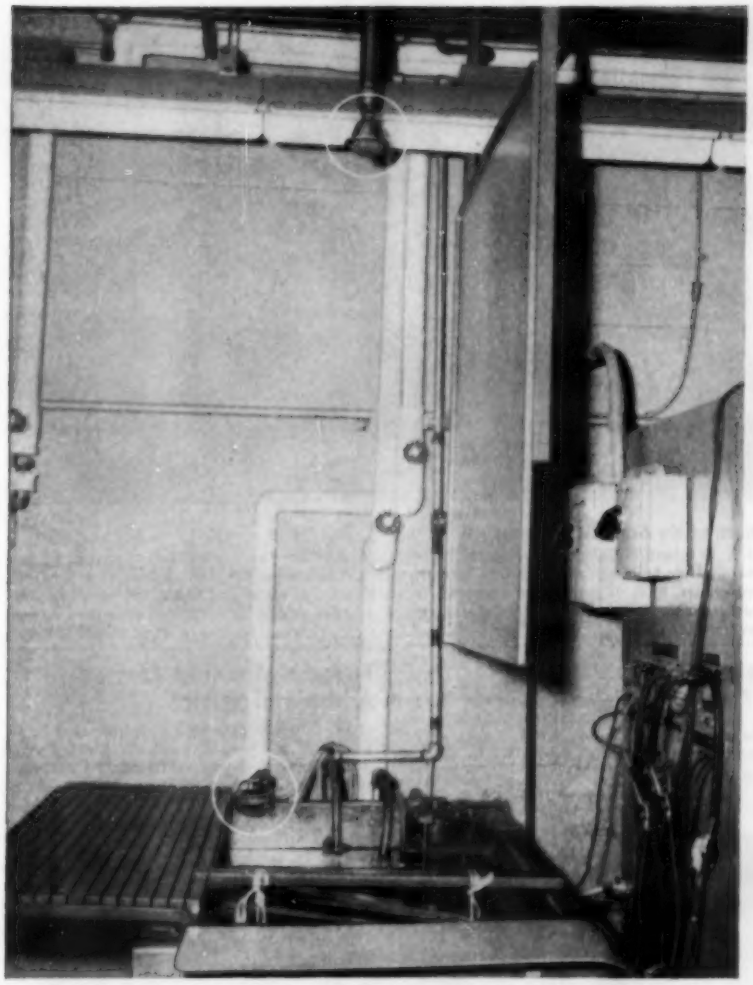


Everything looks quiet in this laboratory. But if flammable oil (below) should ignite, the FogFOAM head (above) would instantly release blanketing FogFOAM from the Rockwood SpotPROTECTION unit.

Hidden Danger Below-
Spot Protection Above

Squelch a flammable liquid fire *before* it can do damage.

With Rockwood SpotPROTECTION you have such a fire hazard "covered" as the picture shows. The heat actuated device below would sense any rapid rise in temperature at once. Then, instantly, the FogFOAM head above would discharge a blanket of Rockwood FogFOAM and quench the blaze. This is Rockwood SpotPROTECTION — a worthwhile money-saving adjunct to your regular fire-fighting equipment.

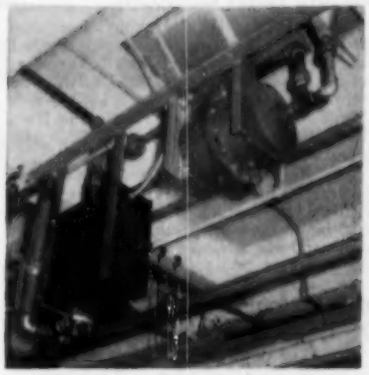
Where flammable liquid hazards exist, ordinary firefighting methods are often ineffective, and at times even dangerous. SpotPROTECTION snuffs out flaming vapors, *without agitating the surface of the liquid*, your best safety factor.

Put SpotPROTECTION to work for you. Send coupon for complete information.

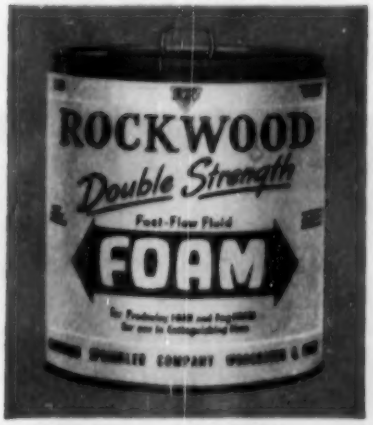
ROCKWOOD SPRINKLER COMPANY

Engineers Water . . . to Cut Fire Losses

How Rockwood Engineers Water to Cut Fire Losses



The circular tank is both for storage and balanced pressure proportioning of Rockwood FOAM liquid into water at a predetermined percentage rate. Model "K" Deluge Valve automatically controls flow of FOAM solution to FogFOAM heads.



Rockwood Double Strength FOAM clings to surfaces as an insulator — FOAM liquid flows freely at sub-zero temperatures. Excellent for extinguishing fires in gasoline, benzol and other highly volatile liquids as well as ordinary combustibles.

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Suppliers . . .

mer manager of the Buffalo, N. Y., district, has been named to head operations at Newark, N. J. He will be succeeded by G. E. Kuehn, who was assistant sales manager of the New York district.

Duff-Norton Buys Coffing Hoist Company

Duff-Norton Manufacturing Company has purchased Coffing Hoist Company and will operate the Danville, Ill., firm as Coffing Hoist Division of Duff-Norton Company.

Duff-Norton is changing its name from The Duff-Norton Manufacturing Company to Duff-Norton Company.

The Pittsburgh, Pa., firm is a manufacturer of lifting jacks and makes a line of ratchet, hydraulic, air-motor and worm-gear jacks. Coffing produces a variety of hand- and electric-operated hoists and allied products.

Inco Names Head Of Casting Section

Kenneth A. DeLong has been placed in charge of the Iron and Non-Ferrous Casting section for the Research and Development division of The International Nickel Company, Inc.

DeLong became connected with International Nickel in 1937, as a member of the Cast Iron section of the company's Research Laboratory at Bayonne, N. J., and in 1940 was transferred to the Development and Research division.

Kansas City Building Opened—

J. E. Pritchard & Company, a firm of engineers, constructors and manufacturers, opened its new general office building in Kansas City recently with an open house for business leaders and out-of-town guests. Built of re-inforced concrete, faced with ledge stone and brick, the new fire-proof structure incorporates many of the latest features in office design. Edward W. Tanner and Associates were architects.

Beryllium Picks Distributor

The Beryllium Corporation has designated Charles A. Strelinger Company as a warehouse distributor for its safety tools. The Detroit firm will cover sales in Michigan.

Burgess-Manning Names Additional Officers

W. C. Bennett, Philadelphia, and S. G. Paddock, Dallas, have been elected vice presidents of Burgess-Manning Company, recently merged with Penn Industrial Instrument Corporation. Bennett and William Melas, also of Philadelphia, will serve as directors.

Mrs. L. S. Kurtzhalz, Philadelphia, was named assistant secretary and H. A. Dietrich was made manager of the company's Libertyville division.

Bennett, Melas and Mrs. Kurtzhalz were officers of Penn Industrial Instrument prior to the merger. Paddock is manager of Burgess-Manning's Dallas division.

Plant Design Firm Formed in England

Harold Moore & Partners (Engineers), Ltd., has been reformed and expanded under a new name. In the future, the Manchester, U. K., firm will be known as H. E. Charlton Engineers, Ltd.

Previously concerned primarily with the design and construction of refineries and

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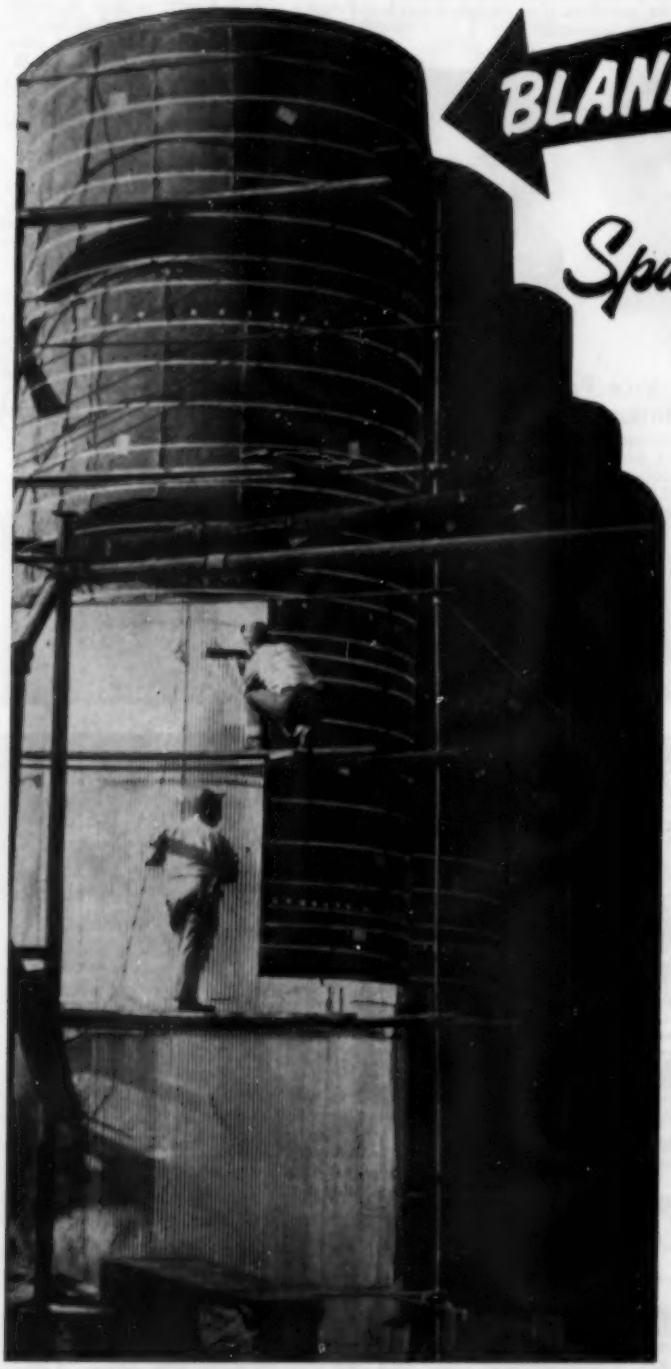

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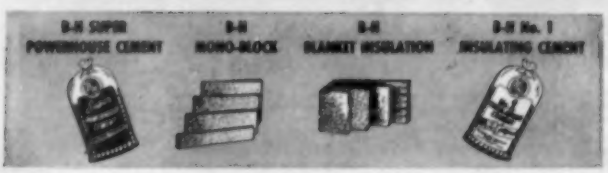
Storage Tanks insulated with 1½" thick B-H Blankets having 1" wire mesh on one side; expanded metal lath on other side.



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  By Morris Jacobs and Leopold Scheflan — price $8.50
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  By Ibert Mellan — price $12.00
- ***The Physical Chemistry of Lubricating Oils***
  By A. Bondi — price $10.00
- ***Elements of Fractional Distillation***
  By C. S. Robinson and E. R. Gilliland — price $7.50
- ***Methods of Analysis of Fuels and Oils***
  By J. R. Campbell and W. Gibb — price $4.00
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  By John H. Perry — price $17.00
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Suppliers . . .

petrochemical plants, the firm now expects to broaden its activities into the chemical and other allied industries.

Strouse

Orr

Franklin Vice President Takes Station in Denver

Leland Strouse, vice president of Franklin Supply Company in charge of the Rocky Mountain-Western Canada area, has moved to new offices in Denver. Strouse, formerly head of the company's operations in the New Mexico-Texas area, will supervise the operation of three Franklin stores in the U. S., as well as a store and office in Canada.

The company also named John L. Orr, formerly with Franklin's sales staff in Chicago, to take charge of an office recently opened in New York. Orr will head a staff assigned to handle eastern and export sales.

Celanese Picks Manager To Head Chemical Sales

Robert H. Kampschulte has been named general sales manager of the Chemical division of Celanese Corporation of America. Kampschulte, who joined the Company in 1947 and has been assistant general sales manager since 1952, succeeds John W. Stevens, who resigned.

Pacific Coast Borax Reassigns Three

L. L. Fusby has been appointed production manager of Pacific Coast Borax Company, division of Borax Consolidated, Ltd. Recently in charge of the company's operations at Boron, Calif., he will headquarter in Los Angeles.

Other new appointments in the Pacific Coast organization include W. J. Diffley, production manager at Wilmington, Calif., named superintendent of the Boron operations. Dr. D. S. Taylor, employed in company research for the past ten years, was assigned as director of industrial research.

Bulkley, Dunton Appoints Four New Representatives

Bulkley, Dunton Processes, Inc., has selected four companies to serve as its representatives in different parts of the country.

H. E. Danby Company, Inc., of Indianapolis, will cover all industries in Indiana except paper, while Nicholas A. D'Arcy, a Huntington, Calif., firm, will service the petroleum industry in Southern California. W. H. Davidson Company of Wayne, Pa., will call on general industries in eastern

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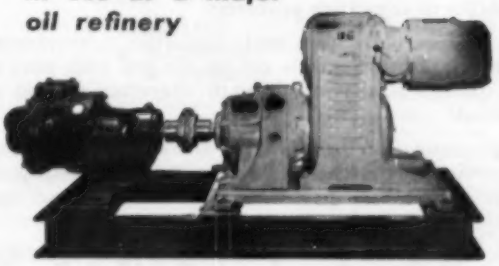

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Pennsylvania, southern New Jersey and Delaware, and John D. Homan, a Tampa company, will represent Bulkley, Dunton in northern Florida.

American District Steam Reorganizes Operations

American District Steam Company, Inc., has changed its name to ADSCO Industries, Inc., and set up two new operating divisions.

Operations at the company's plant in North Tonawanda, N. Y., has become the American District Steam Division of ADSCO Industries, Inc., and the former California Steel Products Company has been renamed California Steel Products Division. The California company, headquartered at Richmond, was purchased by American District Steam about a year ago.

Davison Chemical Fills Eastern Sales Position

I. A. Schwint has joined the Petroleum Catalyst department, Davison Chemical Company division of W. R. Grace & Company, for sales and service contacts with petroleum refiners in parts of the eastern U. S. He joins Davison from the Filtrol Corporation, for which he was eastern representative, and will headquarter in Baltimore.

Kellogg Names McKee To Head Fabricated Sales

Waldo McC. McKee has been appointed sales manager of the fabricated products division of The M. W. Kellogg Company. He had been assistant sales manager of the department since 1944. A mechanical engineer, Mr. McKee joined The M. W. Kellogg Company in 1928.

Chapman Valve Elects Executive Vice Prseident

David M. McIntosh has been elected executive vice president of The Chapman Valve Manufacturing Company. He will continue as vice president in charge of production. Also promoted in the company was Frank A. Hunter, elevated to vice president in charge of sales.

Timken Company Starts Mill Modernization Program

The Timken Roller Bearing Company plans a $360,000 steel-mill expansion program. The Gambrinus piercing mill will be lengthened to pierce tubing up to 130 percent longer than lengths previously processed there. Engineering work on the modernization program is underway.

Acquires Subsidiary

Panellit, Inc., has acquired Jordan Electronic Manufacturing Company, Inc. Panellit will operate the Pasadena, Calif., company as a wholly-owned subsidiary, under its former owner, M. Jordan Nathanson, who will continue as president. Albert F. Sperry, Panellit president, will serve as chairman.

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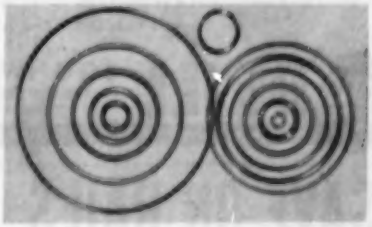

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Phone: SAginaw 1-1900

See Page 243 in Refinery Catalog

For more data on advertised products, use Readers' Service Cards, last page.

PETROLEUM REFINER Classified Ads

Petroleum Refiner New Classified Rates

RATES: Regular Classified (undisplayed) set in this size type: 12 cents per word. Minimum charge, $3. Blind box address in our care counts six words. Replies forwarded without charge. Situation wanted ads, 6 cents per word. Display ads, set in suitably larger type with ruled border, $12 per column inch; situations wanted display ads, $6 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All Classified ads payable in advance.** Copy deadline: 25th of month preceding date of issue. Send copy and checks to: Classified Advertising, Petroleum Refiner, P. O. Box 2608, Houston, Texas.

* * * * * * * * * * * * * * * * *

FOR SALE **FOR SALE**

JUST PURCHASED!

Complete Compressor Station

6—I-R KVG-6 gas engine compressors, 600 & 660 hp complete with accessories
$50,000 new spare parts
2—I-R Starting Compressors, Model 25-C, explosion-proof motors
3—100# vessels, 10′ x 20′, 6′ x 20′, 8′ x 16′
6—Centrifugal pumps, 2000 GPM, 90′ hd; 400 GPM, 290′ hd; 60 GPM, 460′ hd.
6—M. W. Kellogg 2400 sq. ft. ADM heat exchangers

PRICED FOR IMMEDIATE DISPOSAL—WRITE, WIRE, PHONE

Liquidation—Leveland, Texas

6′ x 58′, Chrm. lin. tower, 20 tray, 50#, mfgd. '51
6′-6″ x 55′; 6′ x 27′; 5′ x 27′; 0′-42″ x 49′; 0′-30″ x 35′ steel towers
5—ADM heat exchangers, 1600, 500 sq. ft.
2—800 sq. ft., 675# 800° F heat exchangers
5′ x 40′ Chrm. lin. 90# vessel
4′ x 40′ 325# vessel
BJ 5 stage NiCh 400 GPM, 2000′ hd steel & chrome pipe, valves, fittings and many other items

Equipment Elsewhere

7′ x 26′—SS, 10 tray, 50#
7′-6″ x 56′, 30 tray, 45#
2′ x 60′, 560#
5—300# vessels, 8′ x 30′, 7′ x 30′
2—Pacific 6 stg., 730 GPM, 2000′ hd
3—Clark engines, RA-8-MA-4
10—Steel heat exchangers, 1500, 360, 260 sq. ft.
1—Gould 16″ pump, 15,000 GPM, 135′ hd.

Consult us for Petrochemical Equipment

We have a large stock of equipment such as: Driers, Filters, Mixers, Flakers, Vessels, Pumps and Compressors of all sizes.

New York Office: 2401 3rd Ave. — Phone CYpress 2-5703

BE BRILL EQUIPMENT COMPANY
4101 SAN JACINTO STREET, HOUSTON 4, TEXAS
New Telephone: LOcust 1351
A SINGLE ITEM OR A COMPLETE PLANT
Write, wire or phone us for complete information — Send us your surplus equipment lists today

SAVE ON RAILS

BUY "GUARANTEED RELAYERS"

Handle more cars better — spend less to install & maintain with Foster Relayers. "Open-stock" shipments, all sections 12# thru 175# Switch Materials, Track items.

Send catalogs ☐ *Rails* ☐ *Track Equipment*
☐ *Send Free 'Track Maintenance' Book*

RAILS · TRACK EQUIPMENT · PIPE · PILING
L.B. FOSTER CO.
PITTSBURGH 30 NEW YORK 7
CHICAGO 4 HOUSTON 2 LOS ANGELES 5

All sizes to fit your gages
Send for Catalog
ERNST WATER COLUMN & GAGE CO.
LIVINGSTON, N. J.

• FOR SALE: Surplus Walworth Limitorque Motor Control Valves, 4″ thru 18″. Details furnished on request. Write, wire or phone Purchasing Agent, Texas City Refining, Inc., P. O. Box 1271, Texas City, Texas. Ph. 5-4451.

PROFESSIONAL SERVICES

• JOHN J. HARTE CO., Engineers • Construction Managers—Petroleum • Agricultural Chemicals • Gas Transmission • Reforming • By-Products • Surveys • Complete Plants. 284 Techwood Dr., Atlanta, Ga. • New York • Washington • Houston • Foreign

EQUIPMENT WANTED

• Manufacturers Representative 10 years experience wants lines for sale to Oil, Gas, Chemical industries in New York area. Box 196-R, c/o Petroleum Refiner, Houston, Texas.

HELP WANTED

• MANUFACTURER'S AGENT. Well established manufacturer of Suspended Arches and Sectionally supported walls desires effective representation in Cleveland area; Oklahoma-Kansas area; upstate New York; Wisconsin; Minnesota and Northwest area. Write Manager Arch and Wall Division, Chicago Fire Brick Company, 1467 Elston Avenue, Chicago 22, Illinois.

STAFF ENGINEER

Major operator of gasoline plants has staff opening for qualified process, design and construction engineer. Requires supervisory experience and ability to direct major programs. Must have engineering degree with minimum of ten years experience in the field of gasoline plant design and construction. Salary commensurate with experience and qualifications. Age limit 40.

Send detailed personal and work history with photograph to Box 194-R, c/o Petroleum Refiner, Houston, Texas.

Process Design Engineers

A progressive, major engineering and contracting firm has openings in its Process Design Department for qualified chemical engineers with one to ten years of experience in the process design of petroleum refinery and chemical plant facilities. Offices are in Cleveland, Ohio, convenient to desirable residential suburbs.

All replies are confidential. Send details of education, experience, expected salary, and photograph to:

E. A. KOLNER
Arthur G. McKee & Company
2300 Chester Avenue, Cleveland 1, Ohio

Sales Opportunity

Well known Southwestern business firm needs a chemical engineer with refining background for sales position. If you are 25 to 40, have the desire to sell, are intelligent and willing to work hard, this job offers real money-making opportunity. In your reply, please give your complete education and business history, whether or not you would be willing to relocate. Address Box 190-R Petroleum REFINER.

Managerial Personnel Needed

FOR RESEARCH CENTRE IN THE PETROLEUM INDUSTRY

Ente Nazionale Idrocarburi (E.N.I.) has under its supervision a number of Italian Companies active in the field of petroleum and petrochemicals. ENI's major activity is centered in the following items:

—**gas and oil field exploration and exploitation** (current production: 105 billion cu. ft. of natural gas per year);

—**operator of a 2500-mi. pipe-line system** (capacity over 700 million cu. ft. per day);

—**owner and operator of a tanker fleet of around 120,000 dwt;**

—**owner and operator of an extensive network for distribution of petroleum products and LP-gas throughout Italy (64 Bulk plants, 4000 stations, etc.);**

—**control over or shareholding in refineries having a processing capacity of about 6 million tons of crude oil per year;**

—**owner of factories (1500 employees) for construction of machinery;**

—**shareholding of chemical plants (700 employees) for production of synthetic dyes, detergents, etc.;**

—**under construction, a petrochemical plant (production capacity—30,000 tons per year of synthetic rubber and 350,000 tons per year of ammonium nitrate).**

E.N.I. is organizing a big research centre for investigation and development of petroleum processing and manufacture of petrochemicals. Some departments are expected to begin operation next summer.

Italian or foreign technical experts, with a wide educational background, specific training, organizational and managerial ability, are required to fill positions as heads of the main departments of the laboratories.

Specifically the following are sought:

1) **Chemist or physicist with specific knowledge and experience in thermodynamic and chemico-physical problems;**
2) **Chemist specialized in the preparation of organic compounds, particularly those derived from hydrocarbons;**
3) **Inorganic chemist soundly and completely acquainted with modern methods of of experimentation, research and testing;**
4) **Engineer or industrial chemist specially trained in the methods for improving petroleum products applications;**
5) **Engineer or physicist, with physico-technical and technological training, specialized in the problems of thermo-technics, measurements and controls;**
6) **Engineer or industrial chemist with extensive research experience in the field of crude oils processing;**
7) **Engineer or industrial chemist particularly experienced in extending laboratory procedures to pilot plants;**
8) **Engineer with good theoretical knowledge and laboratory experience in engine tests on fuels and lubricating oils;**
9) **Engineer or industrial chemist specially trained both in theory and practice in the fields of corrosion and protective means for materials.**

Note: University degree mandatory.

Applications should state age and other usual personal data, educational background and qualifications, practical experience, etc., and should include a photograph. Please address personally to the **Presidente dell'Ente Nazionale Idrocarburi, Via Lombardia, 43—Roma—Italy,** with the special note **RISERVATA PERSONALE** (i.e., to be opened by addressee only).

Absolute discretion in every respect is assured.

Salary offered will be in accordance with position, training and qualities required.

EDITORIAL WORK

Editorial work—refining or petrochemical processes, maintenance, process design, mechanical design . . . We are interested in men with degrees in chemical or mechanical engineering, and with 3 to 6 years experience in the refining or petrochemical industry. If you enjoy meeting people, like to read and write, want to broaden your field, enjoy the southwest area for living, and don't mind travelling about 15 percent of the time, then send us biographical data with small photo. Strict confidence. Box 197-R % Petroleum Refiner, Post Office Box 2608, Houston 1, Texas.

SENIOR FURNACE ENGINEER

The design of furnaces to improve process service requires exceptional training and ability. We'd say the minimum was an ME or ChE degree, 8 years' background in furnace design, and a thorough knowledge of heat transfer fluid flow, chemical reaction, metallurgy and strength of materials as applied to furnace design.

The ability to recommend desirable process changes, to develop new designs and design methods requires additional talents as well as initiative.

If you can meet these exacting qualifications, we'd like to meet you. The result can be mutually profitable.

Box 195-R, c/o Petroleum Refiner, Houston, Texas.

CHEMICAL ENGINEERS

Graduates with minimum 3 years' process design experience in oil refinery or surface oil producing facilities. For New York office. Must, however, be willing to relocate in foreign operation at some future date.

Also Chemical, Mechanical and Electrical Engineers with comparable or related experience are needed for process and project work in Arabia. Assignments and salary commensurate with experience and training.

Write giving full particulars regarding personal history and work experience. Please include telephone number.

Recruiting Supervisor, Box 23
ARABIAN AMERICAN OIL COMPANY
505 Park Avenue
New York 22, New York

☆

Petroleum Refiner

Classified ads

don't cost . . .

They PAY

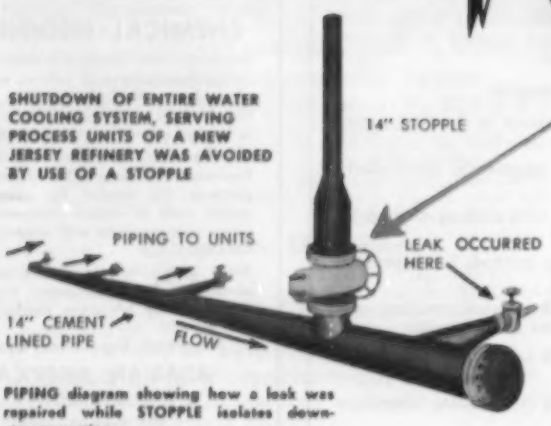
☆

STOP

Shutdown!

WmSON STOPPLE plugs vital 14" water line... permitting repair without shutdown

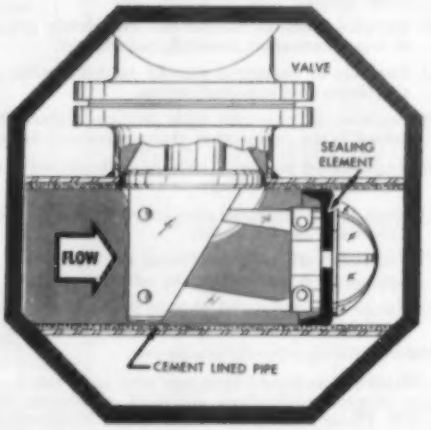
SHUTDOWN OF ENTIRE WATER COOLING SYSTEM, SERVING PROCESS UNITS OF A NEW JERSEY REFINERY WAS AVOIDED BY USE OF A STOPPLE



PIPING diagram showing how a leak was repaired while STOPPLE isolates downstream section.

PROCEDURE

1. **FLANGED** nipple welded to pipe. Hole cut with WmSON-HILLCO tapping machine.
2. **STOPPLE** installed, making complete seal in pipe, isolated the section to be repaired.
3. **REPAIRS** were made while upstream units continued to operate.
4. **STOPPLE** removed, repaired section put back into operation.



CUT-AWAY VIEW OF STOPPLE SEALING ELEMENT

Experienced Williamson representatives, factory-trained, will assist you in the proper use of Williamson STOPPLES and Tapping Machines.

STOPPLES may be rented or purchased
STOCK SIZES: 4" 6" 8" 10" 12" 14" 16" 18" 20" 22"
ALL TESTED TO 800 PSI. OR 1,000 PSI.

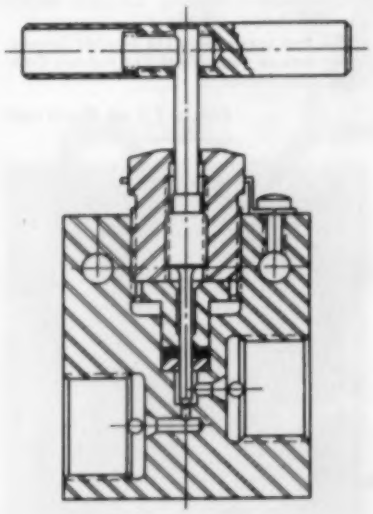
Write For Literature

T.D. Williamson, Inc.

P. O. BOX 4038 • TULSA 9, OKLAHOMA

REPRESENTATIVES: Houston • Pittsburgh • Kenilworth, N. J. • Amarillo • Casper • Provo, Utah • Joliet, Illinois • Los Angeles • San Francisco • Bartlesville, Okla. • Edmonton • London, Ontario • Calgary • Buenos Aires • Durban, Natal, South Africa

What's New In Equipment . . .



High-Pressure Problems?

New Valve Controls 60,000 PSI

A new, 60,000 psi valve has just been developed by Autoclave Engineers, Inc. This unique valve is the product of several years' development work based upon the experience, problems, and needs of a large number of research engineers and chemists in the refining, natural gas, and petrochemical industries. It is designed not only to provide greater operational safety, but also to eliminate the danger of improper valve assembly and to prevent interchangibility with lower pressure fittings.

Design, production, and research engineers will be especially interested in the following improved design features:

The outside diameter of both the collar and gland have been increased for added strength.

The length of the gland has been increased for longer thread engagement.

Internal corners have been machined with a radius and corners of the collar have been chamfered to minimize stress concentrations.

Weep holes have been added at the base of the female thread of the valve and fitting.

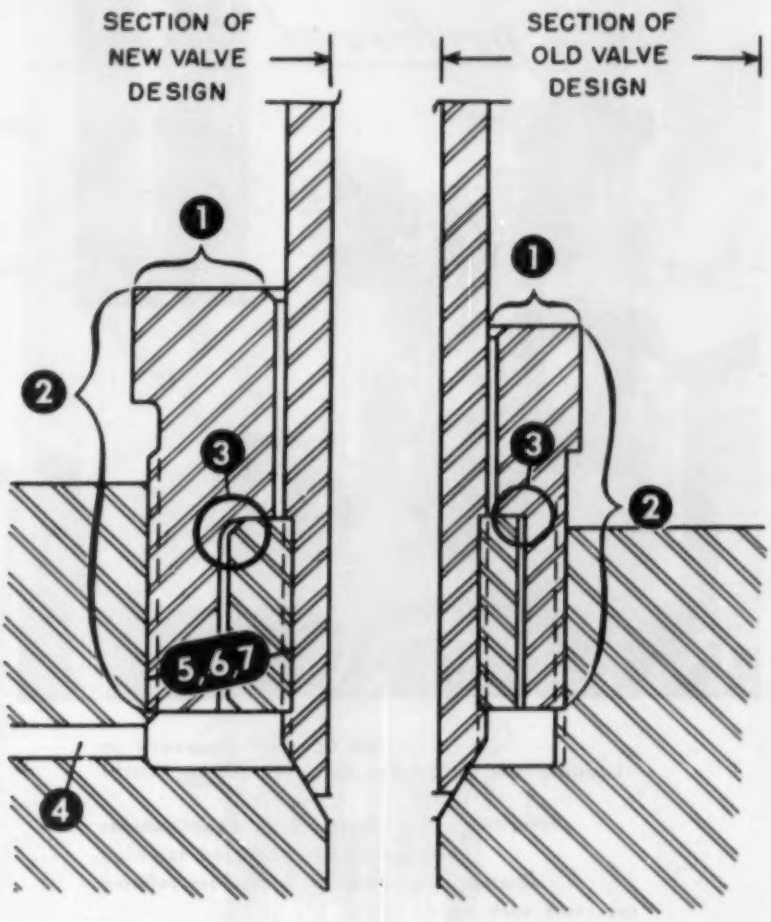
Threads with rounded root are used throughout, eliminating the possibility of interchanging lower pressure fittings.

Threads on the gland are relieved to the base of the thread, thus minimizing stress concentration at this point.

All essential parts are made from type 414 stainless steel, heat treated to 100,000 psi minimum yield with 18 percent minimum elongation.

A bulletin containing complete information on this new and unique 60,000 psi valve is available now. Just . . .

Circle E1 on Postcard



A pressure vessel slide rule and metal weight calculator is now being made available by Alloy Fabricators. This handy slide rule gives weights for alloys and steels in various shapes and sizes. The reverse side charts A.S.M.E. summary for U-68 and U-69 pressure vessels. This handy slide rule and calculator is available to you now. Just . . .

Circle E2 on Postcard

A two-stage temperature control which provides the advantage of staged operation from a single actuating bourdon tube is now available from Mercoid Corporation.

The control incorporates two independently adjustable magnetic mercury switches which provide for successive stage operation or high-low operation. A few typical uses of this new control are:

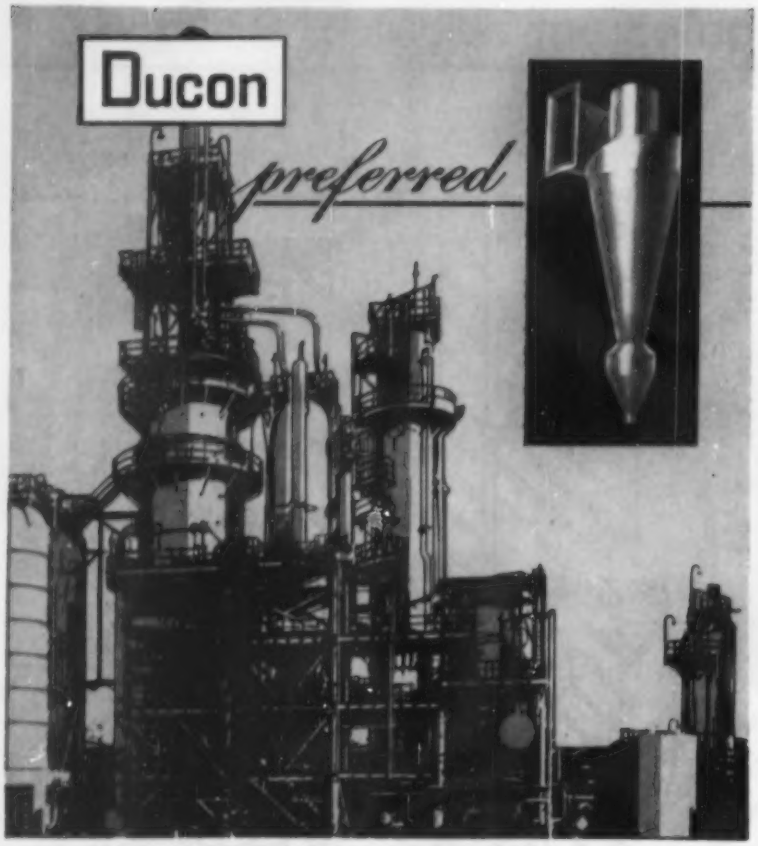
To close one alarm circuit at high temperature and another at low temperature. Both circuits to remain open between the high and low temperature operating points.

As an electrical interlock to open one circuit as temperature rises above, and the second circuit as temperature drops below the set operating points.

To provide two-stage control by opening one circuit on a rise in temperature and a second circuit on a further rise in temperature.

The controls can be furnished in 11 different operating ranges. They are equipped with external adjustments and a visible calibrated dial.

The standard steel case, for general purpose, conforms to NEMA 1. Weather-proof cases and Explosion-proof cases are also



. . . for Catalyst Recovery in Leading Oil Refineries throughout the World

Ducon Type SDC Cyclones are specifically designed for high efficiency operation in petroleum refining processes such as:

- **Fluid Bed Catalytic Cracking**
- **Thermofor Catalytic Cracking**
- **Elutriator Towers**
- **Fluid Coking**
- **Fluid Hydroforming**
- **Catalyst Disposal and Conveying**
- **All Fluid Solid Operations**

Full descriptive literature on request

the name in dust control

Canadian Branch: THE DUCON COMPANY of CANADA, Ltd.
275 James Street North, HAMILTON, ONTARIO

THE **Ducon** COMPANY

147 EAST SECOND STREET, MINEOLA, N.Y. · Sales Representatives in Principal Cities

Designers and Manufacturers of Dust Control Equipment Exclusively

CYCLONES • CENTRIFUGAL WASH COLLECTORS • TUBULAR CLOTH FILTERS • DUST VALVES

New Equipment . . .

available.

A bulletin containing complete details is available now. Simply . . .

This item supplements The Mercoid Corporation data on page 574 of The Refinery Catalog, 22nd Edition.

Circle E3 on Postcard

A "Pressure Pilot" having an integral gauge for process pressure indication and featuring a self contained design has been announced by Hammel-Dahl Company in their new Model 110.

It is an inexpensive instrument incorporating feedback proportional control or differential gap control with snap action over a 2-100 percent band. The all metal power relay makes possible low nozzle pressures for linear response and output pressure up to 30 psi for positive valve action. The sapphire nozzle feed orifice is equipped with a push-button cleaner.

Simplicity of operation, compactness, and versatility are outstanding features of the Model 110. Switching to a different control action, setting the control point, or reversing output action are all accomplished by turning knobs or friction screws. The instrument has all connections on the left side, rear. It can be surface, flush, or valve mounted. Bourdon elements range from 0-15 psi to 0-10,000 psi.

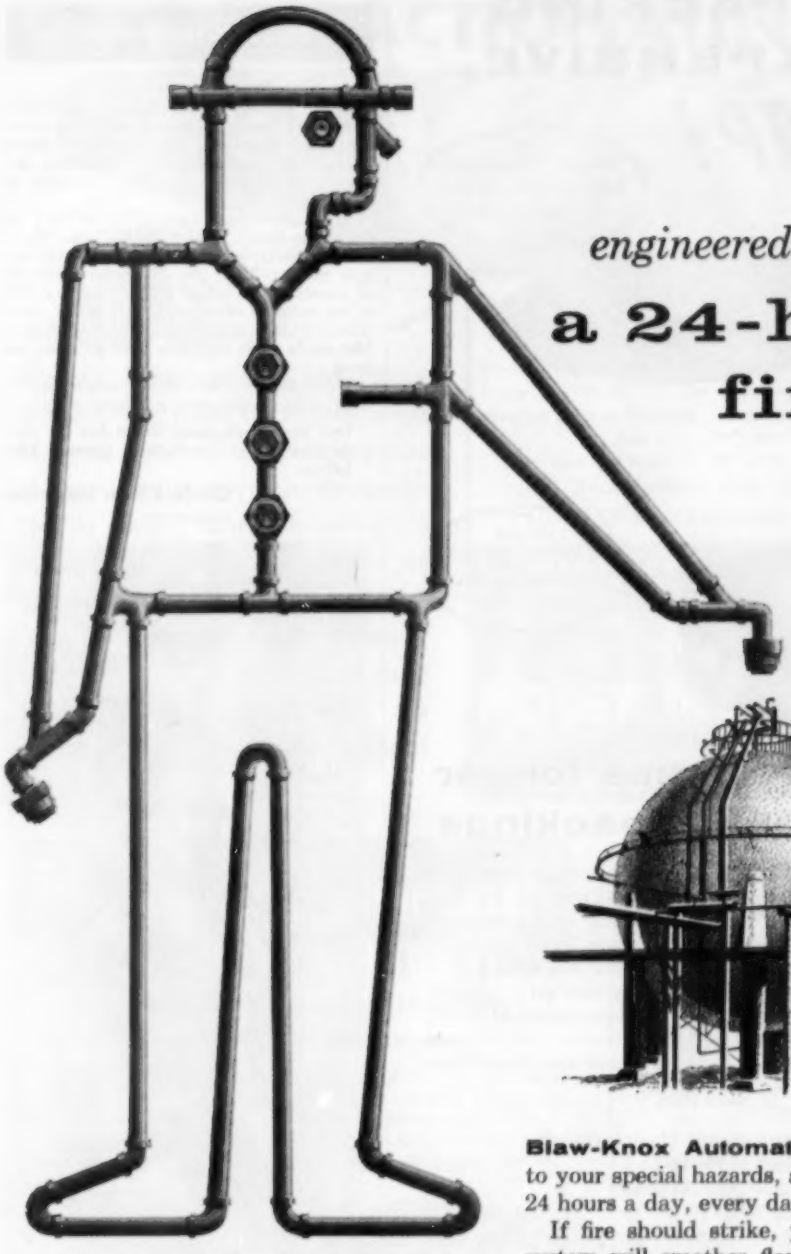
Complete details are available now. Simply . . .

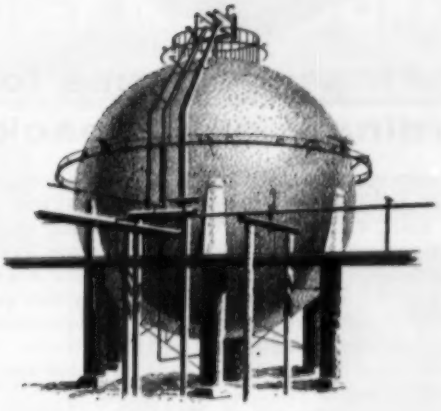
Circle E4 on Postcard

A controlled volume pump for precise control of fluid flow at pressures ranging from 7500 to 50,000 psi has been recently announced by Milton Roy Com-

engineered by Blaw-Knox...

a 24-hour fire guard





Blaw-Knox fire protection systems carry approvals of all insurance underwriters.

• Deluge Systems • Wet Pipe Systems • Dry Pipe Systems • Water Spray and Fog Systems • Rate-of-Rise Sprinkler Systems • Foam and Carbon Dioxide Extinguisher Systems

Blaw-Knox Automatic Fog Systems, engineered to your special hazards, are fire guards that work for you 24 hours a day, every day in the year.

If fire should strike, your Blaw-Knox fire protection system will smother flames and dissipate heat quickly, thus checking possible loss of equipment and lives. It will also save you from such "hidden" dangers as loss of profits during downtime and loss of customers, possibly forever.

Blaw-Knox engineers have wide experience in water fog protection of chemical installations. We will gladly submit a layout and cost estimate of your requirements at no obligation. Why not call us today?

Send for a copy of our booklet, "Fire Can Destroy Your Business." You'll find it full of interesting facts.

"Little Joey Sprinkler" always on the job

BLAW-KNOX COMPANY

Automatic Sprinkler Department / Pittsburgh 33, Pa.

For more data on advertised products, use Readers' Service Cards, last page.

A PUMP PACKING THAT'S EXPENSIVE, BUT CHEAP!

Heavy Teflon† impregnation throughout
Choice of Canadian white asbestos or blue African asbestos
Unique LATTICE BRAID* construction plus Teflon core

Lasts at least 3 times longer than ordinary pump packings

Frankly, the service reports on LATTICE BRAID asbestos packing with Teflon surprised us! Originally designed and test-proven for use against severe acids, caustics, and other chemicals, this particular packing has out-performed other packings (*even our own*) on more common applications against water, steam, solvents, and oils.

And here's why: (1) The LATTICE BRAID construction gives greater strength; (2) The Teflon core and heavy Teflon impregnation resist everything except molten alkali metals and some freons; (3) It does not adhere to the shaft or rod; (4) It runs smoother and freer than packings without Teflon.

Check these typical service reports:

- Against blending waxes and steam (for cleaning), it outlasted another Garlock style 10 to 1
- Against caustic at 325°F., 50 p.s.i., it outlasted competitive packing 38 to 1
- Against cold water, it out-performed other packings 3 to 1

LATTICE BRAID with Teflon is available in either Canadian white asbestos (style 5861) or blue African asbestos (style 5880). Each is furnished in packing sizes 5/16" to 1½" graduated by sixteenths.

Try an order of 10 feet or more today. Chances are you can *reduce* down-time, maintenance and replacement costs to *one-third* of their present amount.

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

Sales Offices and Warehouses: Baltimore • Birmingham • Boston • Buffalo Chicago • Cincinnati • Cleveland • Denver • Detroit • Houston Los Angeles • New Orleans • New York City • Palmyra (N.Y.) Philadelphia • Pittsburgh • Portland (Oregon) • Salt Lake City • San Francisco • St. Louis • Seattle • Spokane • Tulsa.
In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.
*Registered Trademark †The Du Pont Company's Trademark

GARLOCK LATTICE BRAID with TEFLON

New Equipment . . .

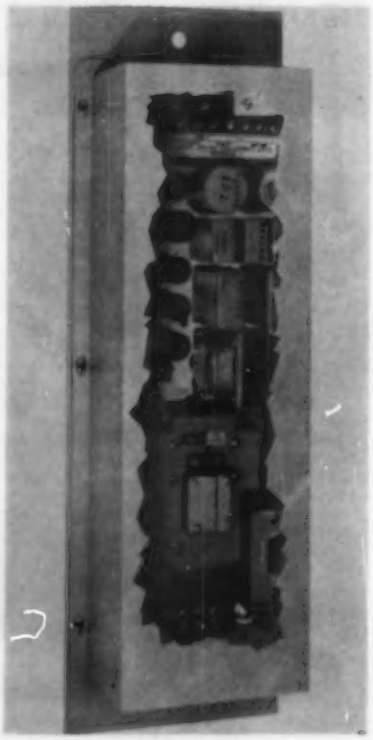
pany. Ideal for high pressure syntheses, hydrostatic pressure testing and high pressure fluid metering, this new flow control instrument provides precise metering accuracy at higher capacities as well as higher pressures.

Seven different units are offered to cover the range 7500 to 50,000 psi. Maximum capacity at 50,000 psi is 12.5 gallons gph and at 7500 psi—94 gph. Materials of construction below 25,000 psi are 300 series stainless steel with 400 series trim. Above 25,000 psi, selected grade of Ni-Cr-Mo steels with tungsten carbide trim are used.

For details on how these pumps may be used to help solve your problems, simply...

This item supplements Milton Roy Co. data on page 587 of The Refinery Catalog, 22nd Edition.

Circle E5 on Postcard

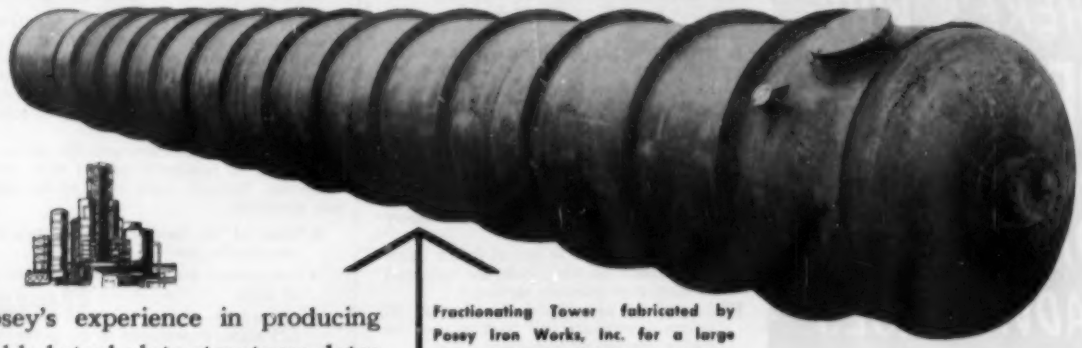


An EMF/Pneumatic Transmitter, manufactured by The Foxboro Company, converts electrical measurements of such process variables as temperature, speed, power and PH, into a proportional 3 to 15 psi pneumatic output.

Easily mounted on the back of a control panel, the transmitter receives a millivolt signal from the measuring element, converts it into a proportional 2000 cps a-c voltage, amplifies and filters the signal, and feeds it to a phase detector circuit. The resulting d-c output is passed through a temperature-stable resistor and a transducer winding, connected in series.

Current through the resistor provides inverse feedback equivalent to 99.8 percent of the input signal, thus minimizing amplifier variations and providing maximum

POSEY FRACTIONATING TOWERS



Fractionating Tower fabricated by Posey Iron Works, Inc. for a large chemical plant in Michigan. 8' diameter . . . 70' high . . . ⅜" skirt . . . ½" shell and head . . . ⅜" trays

Posey's experience in producing welded steel plate structures dates back to 1910 . . . so Posey has the experience as well as the facilities to design, fabricate and erect almost any type of structure required by the Petroleum Industry. You can trust Posey for refinery structures built to your most rigid specifications. Please write for information or estimates without obligation.

Steel plates fabricated by Posey meet all ASME, API-ASME and API codes

ELEVATED TANKS • HORIZONTAL TANKS • STACKS
PRESSURE VESSELS • DIGESTERS
CARBON STEEL AND ALLOY STEEL PLATE FABRICATION
DREDGE PIPE AND ACCESSORIES

POSEY IRON WORKS, INC.

Steel Plate Division Lancaster, Penna.
New York Office: Graybar Bldg. Established Since 1910

Now! for greater safety

New Safety GRIP-STRUT stair treads custom made to your exact size . . . Here for the first time is a really SAFE stair or ladder step, combining the proven features of Safety GRIP-STRUT material with a double locked carrier plate to provide additional safety over present types.

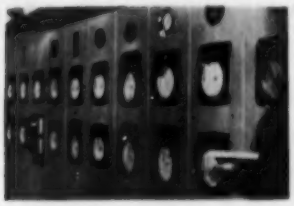
Made to your own individual size at the factory, the cost is amazingly low . . . you can buy a standard 18" stair tread in lots of 50 for $2.40 each. Prices proportionately lower in greater quantities.

Distributors in all principal cities. Consult your classified telephone directory.

GRIP-STRUT division
The Globe Company
Manufacturers since 1916
4008 S. Princeton Ave. • Chicago 9, Illinois

DOLLINGER DELIVERS #1

PRECISION INSTRUMENT PANELS



Examples of Dollinger's precise workmanship are these instrument panels for a Gulf Coast refinery. The panels, made from 3/16" mild steel plate, were produced and formed on our press brake.

When precision is a must—call on Dollinger.

STEEL BY DOLLINGER

AROUND THE WORLD

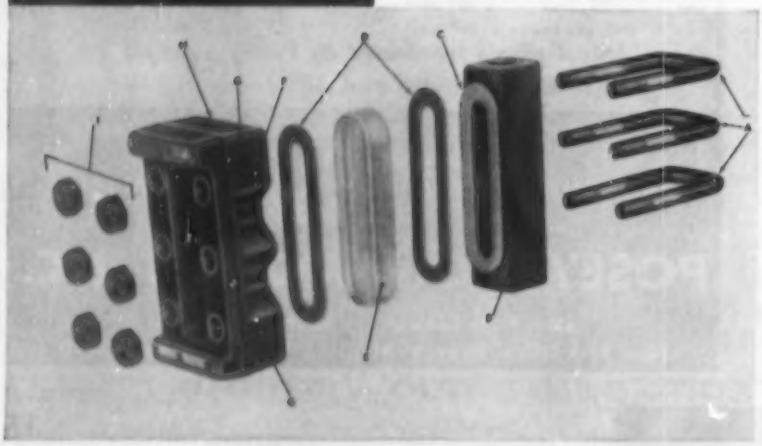
For more than 50 years quality producers of structural steel and plate steel.

JOHN DOLLINGER, JR., INC.
BEAUMONT, TEXAS

HERE'S WHY
PENBERTHY
REFLEX GAGES
OFFER EXTRA
ADVANTAGES

CLEAR, ACCURATE LIQUID-LEVEL READINGS
In all tanks, boilers, vessels, containers, flow lines.
PENBERTHY REFLEX GAGES TYPE V & S

- **A** Alloy Steel Bolts for high temperature service
- **B** Alloy Steel Liquid Chamber heat treated to prevent warping
- **C** Raised Face on Liquid Chamber insures perfect self-alignment of frame with glass and gasket.
- **D** Special Composition Gaskets and Cushions are interchangeable
- **E** Resilient Band around glass centralizes it at assembly.
- **F** Drop Forged Steel Frame extra heavy and rigid
- **G** Extra heavy beam at end of Frame (prevents distortion when bolts are tightened to meet high pressure service)
- **H** Frame overlaps liquid chamber at all points — provides full backing for the gasket preventing blow-outs
- **I** Alloy Steel accurately threaded nuts



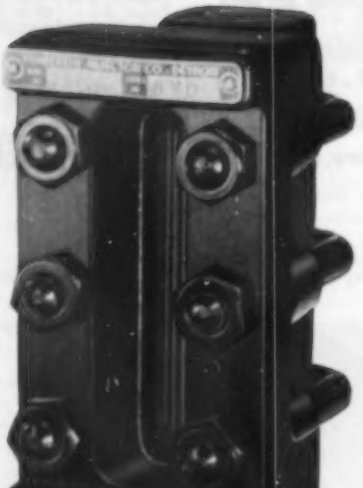
RAISED FACE
IS EXCLUSIVE FEATURE

The construction of a Penberthy Gage invites comparison to prove superiority. Note especially the easy glass or gasket replacement and glass cleaning made possible by the fully accessible RAISED FACE. Perfect alignment of frame with glass and gasket is assured. Gasket surface can be repaired without removing assembly from vessel.

Designed for temperatures ranging from sub-zero to over 1000°F. and for test pressures exceeding 15,000 psi., Penberthy gages are used extensively for liquids ranging from water to highly corrosive and dangerous chemicals.

Available in a wide variety of materials including bronze, iron, carbon steel, stainless, monel, etc.

WRITE for Catalog No. 33. Order through your jobber or direct.



PENBERTHY INJECTOR COMPANY
Division of the Buffalo-Eclipse Corporation
1242 Holden Avenue, Detroit 2, Michigan

There's Certain Satisfaction in
PRODUCTS BY PENBERTHY

- GAGES
- EJECTORS
- EDUCTORS
- EXHAUSTERS
- SYPHONS
- ELECTRIC SUMP PUMPS
- CYCLING JET PUMPS
- INJECTORS

New Equipment . . .

stability. The current through the transducer winding provides a magnetic force that proportions a flapper-nozzle assembly to produce an air relay output proportional to the original d-c measurement. This output then is transmitted to an indicator, recorder or controller.

Standard transmitters provide spans as narrow as 10 millivolts and as wide as 60 millivolts. Special units with wider spans are available.

- Some of the specifications of this new transducer are:
- Instrument sensitivity — .05 percent of scale.
- Accuracy—plus or minus 1 percent of full scale, repeatable to ¼ percent.
- Step-function input of zero to 100 percent of range changes output signal from 3 to 15 psi in 4 seconds or less.

A technical report containing complete specifications is available now.

Circle E6 on Postcard

A low priced self-propelled air compressor known as the Standard Pneumatractor is now being offered by Schramm, Inc. For several years Schramm has been marketing a self-propelled air compressor known as the Heavy Pneumatractor which is capable of mounting a front end loader and backhoe, and other heavy duty accessories.

Due to the increased demand for a similar type of unit for air compressor service primarily, Schramm has taken the same 125 cfm engine compressor power plant used in the heavy Pneumatractor and has built it into a self-propelled tractor unit.

None of the compressor performance has been sacrificed—only the tractor features have been modified to permit the lower cost for those customers interested primarily in the self-propelled air compressor.

Complete details on this new and economically priced self-propelled compressor are available now.

Circle E7 on Postcard

Heavy duty chemical process pumps designed for continuous operation have been introduced by The Duriron Company in its entirely new line of Series H Durcopumps. These pumps are built for high heads and low capacities as well as routine transfer services.

Designed to handle the most severe pumping problems, Series H Durcopumps are simple, sturdy and versatile. A large shaft and heavy bearings provide minimum shaft deflection. Suction and discharge are

buell
dust recovery
really pays off, too!

BUELL ENGINEERS help you to get greater "returns" from your valuable industrial dusts because they deal in FACTS! Important, too, they give you *all* the facts before your company invests a cent.

WITHOUT OBLIGATION...Buell Engineers submit samples of your valuable dust to their laboratory for analysis...make a thorough, on-the-spot study of your operations!

THEY RECOMMEND from the complete line of Buell Dust Recovery Equipment the unit, or combination of units... that is most suitable for your operating conditions.

BUELL "SF" ELECTRIC PRECIPITATOR with its exclusive "Spiralectrodes" and continuous cycle rapping! Buell Cyclone Collector with its exclusive "shave-off" design! Buell PMV Non-Returning Hopper Valves with their positive sealing and self-cleaning features! These are just some of the reasons why Buell Engineers can offer you the ultimate in valuable dust recovery.

THEY TELL YOU EXACTLY HOW MUCH valuable dust can be recovered from your operation . . . before you become obligated in any way!

WHY WAIT? With "profits" to gain...nothing to lose...why not take advantage of this generous proposition right away?

WRITE TODAY for free booklet: The Collection and Recovery of Industrial Dusts—which clearly explains *all three* Buell Systems. Dept. 21-E, Buell Engineering Company, 70 Pine Street, New York 5, N. Y.

buell®

MECHANICAL ELECTRICAL

20 Years of Engineered Efficiency in
DUST RECOVERY SYSTEMS

For more data on advertised products, use Readers' Service Cards, last page.

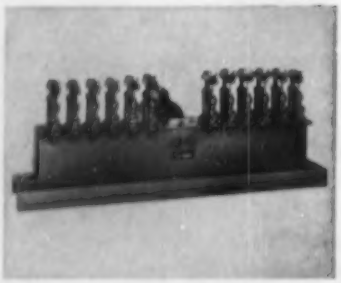
What's Your Problem?

PRESSURE LUBRICATION?

Manzel Force Feed Lubricators are known throughout the Oil and Gas industries for their dependable, economical operation in putting the right amount of lubricant, precisely where it's needed, with the exact frequency required. If you have specific, difficult problems, Manzel can solve them with specially engineered installations.

CHEMICAL FEEDING

Here, again, the Manzel organization has wide experience in meeting the peculiar needs of the Oil and Gas industries with Chemical Feeders of proven dependability under the most exacting operating conditions. Models are available with single or multiple feeds and with capacities of from a few drops to 60 gallons per hour.



For The Answer

Engineered To Your Specific Needs

CALL

Manzel

DIVISION OF FRONTIER INDUSTRIES, INC., 285 BABCOCK ST., BUFFALO 10, N. Y.

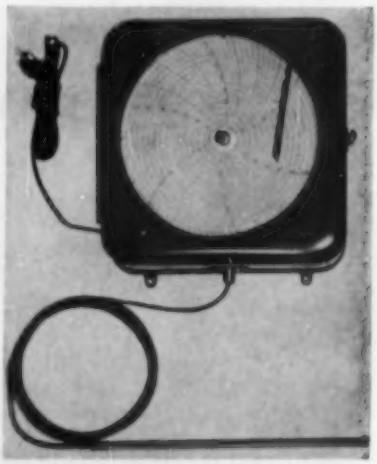
New Equipment . . .

integral with the casing. Minimum parts inventory results from the flexibility of the adaptor and the bearing housing. Each adaptor accommodates several pump sizes, and the entire range of sizes requires just three bearing housings.

This new line of pumps is available in standard Durco corrosion resisting alloys including Durimet 20, Chlorimet 2, and Chlorimet 3, as well as in stainless steels and other materials.

Basic details regarding these pumps are contained in a new bulletin which is available now. Just . . .

Circle E8 on Postcard



A new recorder for temperature, pressure, electrical operation, or mechanical motion is now available in the Dickson Company's Minicorder Design 2. Provision for two pens to record comparative information in certain ranges, as well as an increase of over 200 percent in chart scale distinguishes this new design.

These advantages have been introduced without sacrifice of compactness of construction or the dependable performance for which Minicorder Design 1 is known.

Eight types and about 100 different charts are now available all for the following ranges of time-related recording:

- Temperatures from as low as -200 F to as high as 1000 F.
- Pressure from 0 to 10 inches of water to as high as 2000 psig.
- Charge speeds from 1 revolution per hour to 1 revolution per seven days.
- Choice of spring wound or electric clocks.

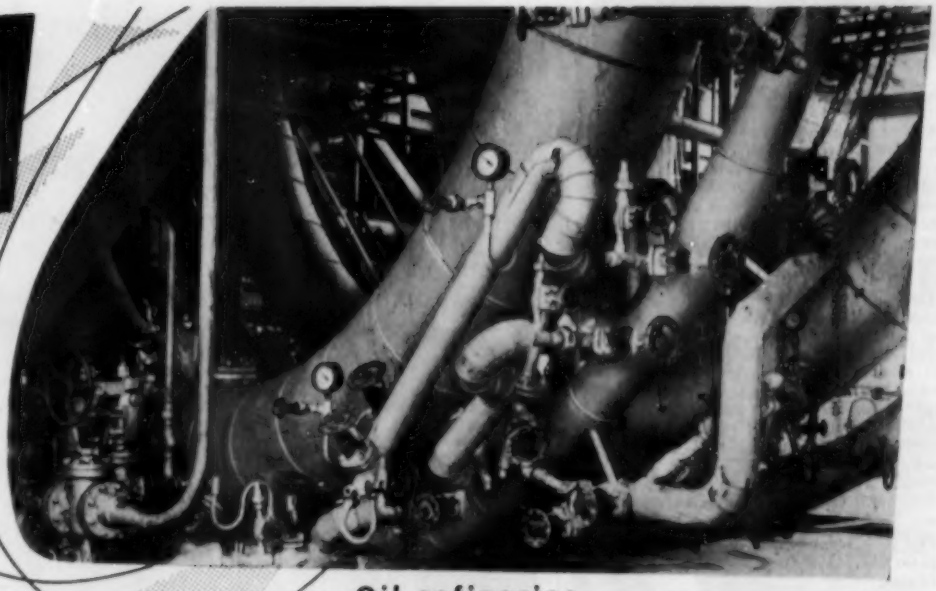
Available in three cases, wall mounting, panel mounting, or table type, Minicorder Design 2 is sealed against dust, moisture, and weather.

Complete details are available on Design 2 now. Simply . . .

Circle E9 on Postcard

A multiple branch tee with integral extruded outlets has been introduced by Tube Turns, division of National Cylinder Gas Company. This new Tube Turn unit makes possible a sound and economical solution to many header problems in the

B&R



Oil refineries
in many countries successfully equipped their modern plants with B&R Gate Valves, Globe Valves, Swing Check Valves, Safety Valves. B&R Valves are manufactured according to API specifications. Flange dimensions conform to ASA. Materials correspond to ASTM. One trial with our valves will make you our customer for ever. Please ask for B&R catalog We 110e with detailed particulars on our lines of **oilfield and refinery equipment.**

BOPP & REUTHER G·M·B·H MANNHEIM - WALDHOF
WESTERN GERMANY

We 538 A

How Metallizing saves money in refineries

cuts machine repair costs 80%—
cuts equipment "down-time"—
permits reduced spare parts stocks

Practically any worn machine part—repaired for only 15 or 20% of replacement cost—in minutes and hours, instead of days or weeks.

Pump shafts • Impeller journals • Motor shafts
Rotor blades • Packing areas • Pump plungers

The list of metallizing users in the Petroleum field reads like a Blue Book of the industry. Here are just a few:

Cities Service Refining Co. — Ohio Oil Co.
Esso Standard Oil Co. — Phillips Petroleum Co.
Gulf Oil Co. — Socony-Vacuum Oil Co.
Imperial Oil Co. (Canada)

See our 8-page Bulletin in Sweet's File for Plant Engineers; or write

METCO

Metallizing Engineering Co., Inc.
1157 Prospect Ave., Westbury, L. I., New York · cable: METCO
In Great Britain: Telephone: EDGEWOOD 4-1300
METALLIZING EQUIPMENT COMPANY, LTD.—Chobham near Woking, England

IMPORTANT SAFETY for your plant!

Slip-resistant

Tri-Lok and Tri-Forged

Serrated grating and stair treads

Don't take chances in those plant areas where grease, oil or other conditions make floors slippery and dangerous! Play it safe with the non-skid, notched surface of *Tri-Lok* or *Tri-Forged* serrated grating and stair treads. Here is a walking surface that is hazard-proof and the ultimate in safety. To be sure you have complete information on all *Tri-Lok* and *Tri-Forged* products, write today.

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DRAVO
CORPORATION
Pittsburgh 22, Penna.
National Distributors

For more data on advertised products, use Readers' Service Cards, last page.

New Equipment . . .

refining, natural gasoline and petrochemical industries.

A recent change in the code for Pressure Piping, Section 8, paved the way for the new product. It requires the use of welding tees, among them the Tube Turn multiple branch tee, or full encirclement reinforcement, for the larger diameter openings and working pressure developing hoop stresses exceeding 50 percent of the yield strength of the run pipe.

The Tube Turn multiple branch tee conforms to the code for Pressure Piping area replacement formula. It is especially useful where branch outlets are appreciably smaller than the run pipe. The new product is "tailored" to individual jobs. That is, its size, wall thickness and the number and size of the outlets are determined by individual service conditions. These new units are available in all commercial metals and alloys.

Complete details are available now. Just . . .

This item supplements Tube Turns data on pages 842-843 of The Refinery Catalog, 22nd Edition.

Circle E10 on Postcard

A portable Therm-O-Meter with fast readings from -50 F to plus 1000 F is now being marketed by Simpson Electric Company, manufacturers of the Simpson 260 D.O.M. Called Model 388, this new instrument measures temperature at the end of a 7½-foot thermocouple lead. It is only 7-15/16 inches wide by 6 inches high by 2-15/16 inches thick. The unit comes complete with an internal battery, a single general purpose lead, Adjust-A-Vue handle, and is priced at just $59.50.

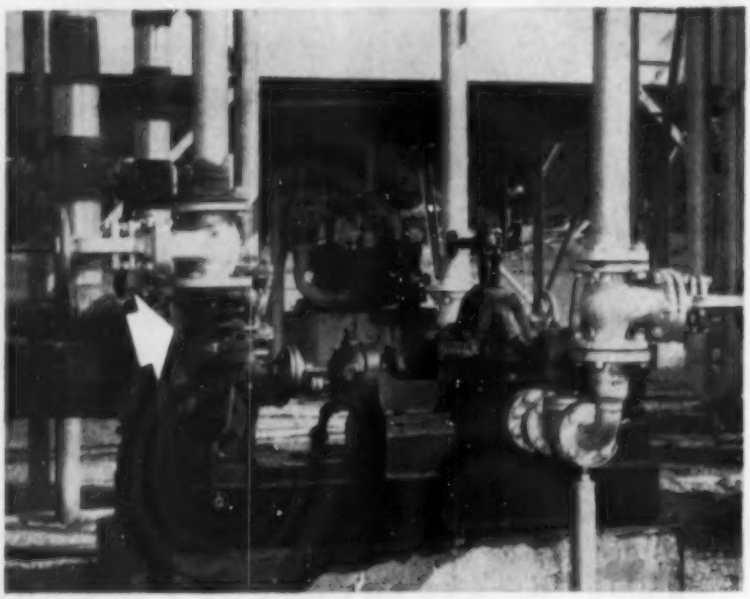
For additional details on this new instrument, simply . . .

Circle E11 on Postcard

All-Silicone-Rubber insulation for large motors and generators has been announced by Allis-Chalmers Manufacturing Co. Known as the Silco-Flex system, it is immediately available for all Class H insulated form wound coils and for Class A & B windings operating under certain service conditions.

Using Dow-Corning's Silastic silicone rubber, Silco-Flex insulation makes avail-

Flexon Expansion Joint Solves Expansion, Misalignment Problems in This Steam Line



FLEXONICS
A Single Source for Every Expansion Joint Requirement

Flexonics Corporation manufactures a complete line of expansion joints in free-flexing, controlled-flexing and special types. Sizes range from 3" up.

Ask for your copy of the Flexon Expansion Joint Design Guide. It provides application and installation data for a wide range of services.

Typical of thousands of routine services is the steam line to a turbine on a deaerating pump illustrated above. Pressure is low and constant; temperature is only 225° F. However, the protection afforded by the Flexon Expansion Joint is as essential to this line as it would be to any.

Thermal expansion results in axial motion and there is a slight offset as well. Without the dependable protection provided by the Flexon Expansion Joint, dangerous stresses would be set up which might eventually result in piping failure.

Protection of piping from the dangers of thermal motion and misalignment is the job of Flexon Expansion Joints. They are manufactured by pioneers in the fabrication of corrugated metal assemblies with over 53 years of manufacturing experience. For routine or unusual applications, play it safe in your piping, specify Flexon Expansion Joints.

Flexonics *Corporation* — EXPANSION JOINT DIVISION

1336 S. THIRD AVENUE • MAYWOOD, ILLINOIS

FORMERLY CHICAGO METAL HOSE CORPORATION

Flexon identifies products of Flexonics Corporation that have served industry for over 53 years.

Manufacturers of flexible metal hose and conduit, expansion joints, metallic bellows and assemblies of these components.

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Here's the FAST way to Strip Paint!

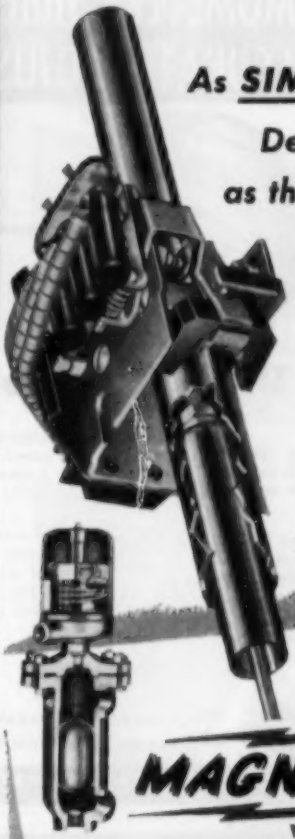
The rake-like device pictured above is part of an Oakite Hot Flow-On paint stripping unit. Easily constructed from tubing and connections found at any refinery, this "mechanized" paint stripping unit is just one of numerous techniques developed by Oakite engineers to increase refinery maintenance efficiency.

The Oakite Hot Flow-On method for stripping paint from storage tanks is both simple and economical. A specialized Oakite paint stripping solution is flowed over large areas by means of the "rake" attachment. As the quick-acting solution drains down the side of a tank, it is reclaimed in a trough at the bottom (see below); then recirculated again, so that no solution is lost by costly drain-off. The entire procedure is automatic; once the proper equipment is set up it requires but two men to operate.

Complete drawings and specifications for constructing this handy unit are available to you, without charge, from your nearby Oakite Man. Call him today for more details on this, and many other modern Oakite techniques for improving your refinery maintenance program. Or write Oakite Products, Inc., 50B Rector Street, New York 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING
OAKITE
MATERIALS · METHODS · SERVICE
SCIENCE

Technical Service
Representatives in Principal Cities of U. S. and Canada



As SIMPLE and Dependable as the Pull of a MAGNET!

A sleeve, raised and lowered within a non-magnetic tube, attracts or releases an Alnico magnet attached to a mercury switch. Basically, this is Magnetrol.

MAGNETROL

The Simplest, Most Versatile LIQUID LEVEL CONTROL Ever Devised!

Linked to liquid level by infallible magnetic force, Magnetrol is free from the limitations inherent in mechanical or electrical controls. With the actuating magnet rated at 98% of initial strength after 30 years, Magnetrol has *infinite operating life*, with practically no maintenance at all. There are no wearing parts to get out of order.

What's more, Magnetrol's simple operating principle permits easy, economical modification of standard units to meet *any* pressure, temperature or corrosion requirements. That's why there's practically no limit to Magnetrol's use. It's also why "specials" are likely to be standard with us. Magnetrol units control level changes from .0025-in. to 150-ft. —with single or multi-stage switching.

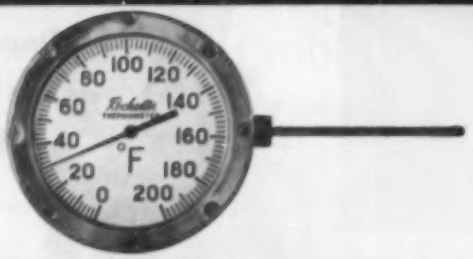
MAGNETROL, Inc.

● SEND COUPON FOR DETAILS

MAGNETROL, Inc. 2112 S. Marshall Blvd., Chicago 23, Illinois
Please send me catalog data and full information on Magnetrol Liquid Level Controls.
Name_____
Company_____
Address_____
City_____ Zone_____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

For THERMOMETERS that are DURABLE, ACCURATE, ADJUSTABLE



USE

Rochester Dial Thermometers

Hermetically sealed against moisture and dirt to bring you years of trouble free service.

Designed to be used indoors or out, the stainless steel case is impervious to most corrosive agents.

Recalibrate the dial externally by inserting the stem in liquid of known temperature and adjusting screw attachment.

Rochester Straight-Form Thermometers bring you the added advantage of a stem that can be mounted in any position around the dial.

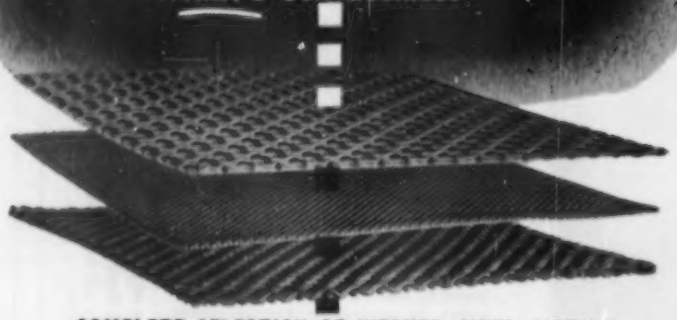
For additional information contact your Rochester sales engineer or write:

Rochester Manufacturing Company, Inc.
38 Rockwood St., Rochester 10, N. Y.

ROCHESTER GAUGES

DIAL THERMOMETERS GAUGES AMMETERS

Sure, we sell HOLES but our
STRAINERS & FILTERS
ARE MADE OF REAL QUALITY MATERIALS
BY MASTER CRAFTSMEN
THAT'S OUR BUSINESS



COMPLETE SELECTION OF WEAVES, SIZES, METALS

For long life and accuracy—Specify **"Cleveland."** We weave wire cloth & wire screens, we fabricate strainer and filter screens to individual job requirements. Quantities: One to One Million in all commercial metals and alloys.
We have the equipment, facilities, and experience to better serve your needs for strainer and filter elements.

WRITE FOR BULLETIN No. 7

THE CLEVELAND WIRE CLOTH & MFG. CO.
3573 E. 79th STREET · CLEVELAND 5, OHIO

New Equipment . . .

able the outstanding advantages inherent in silicone base insulations. Previous use of silicones in rotating machines has been generally limited to resin compounds in combination with glass tape and mica. While all silicone insulations possess outstanding thermal endurance and moisture resistance, silicone rubber, in addition, has the flexibility and resilience formerly obtainable only in organic rubber.

Some of the advantages of the Silco-Flex system are:

- Increased abrasion resistance.
- Chemical inertness.
- Improved heat dissipation.
- Improved moisture resistance.
- Excellent aging qualities.
- Details are available on this new insulating system now.

This item supplements Allis-Chalmers Manufacturing Co. data on pages 109-116 of The Refinery Catalog, 22nd Edition.

Circle E12 on Postcard

Hermetically-sealed motor-pumps will zero leakage in capacities from 5 to 17,000 gpm are available from Westinghouse Electric Corporation. Although originally designed to circulate water between the nuclear reactor and the steam generator in a high-temperature, high-pressure, closed loop system, these pumps should provide a convenient means of pumping fluids at system pressures up to 2500 psi and temperatures as high as 650 F.

Standard designs should be ideal for handling hazardous chemicals or materials which could contaminate products and special designs are available for handling liquid metal at system temperatures as high as 1000 F. Other special designs are available to handle liquids at system pressures up to 10,000 psi. All parts in contact with the pumped fluid are made of corrosion resistant alloys.

There are no external shaft seals in these pumps, and suction and discharge nozzles are designed to be welded into the pipeline. The pumped fluid is allowed to fill the motor cavity, but is excluded from the rotor and the stator windings by sealing jackets in the magnetic gap. An external supply of ordinary clean water for cooling is the only auxiliary requirement.

This newly designed "canned motor pump" is available now. Just . . .

Circle E13 on Postcard

An instrument for the determination of Wobbe Index is now being made available by Sigma Instrument Company, Ltd. This device measures and records the Wobbe Index of rate of thermal delivery, which is a number proportional to the caloric value of the gas being measured and inversely proportional to the specific gravity of the gas being measured. The instrument can be used to control the rate of thermal input to a given unit.

This is a new instrument and a new approach to controlling the problems of gas fired units. It should find considerable application in the refining, natural gasoline and petrochemical industries. For additional information, simply . . .

Circle E14 on Postcard

FREE 112-page handbook of

TUBE CLEANING equipment

NEW WILSON CATALOG GIVES DATA ON:

- *air-driven cleaners*
- *drill type cleaners*
- *electrically-driven cleaners*
- *water-driven cleaners*
- *cutter heads*
- *air-driven motors*
- *electric motors*
- *steam-driven motors*
- *water-driven motors*
- *and many accessories*

FOR CLEANING THIS EQUIPMENT:

- *boilers*
- *gas coolers*
- *sulfite evaporators*
- *glycerine evaporators*
- *fuel oil heaters*
- *polymerization units*
- *miscellaneous evaporators*
- *humidifier tubes*
- *water heaters*
- *crude column heaters*
- *small transfer lines*
- *miscellaneous heaters*
- *miscellaneous condensers*

FOR THESE INDUSTRIES:

- *air conditioning*
- *refrigeration*
- *oil refineries*
- *synthetic fibers*
- *electro-chemical*
- *synthetic rubber*
- *paper*
- *food process*
- *steel*
- *manufactured gas*
- *chemical*
- *pharmaceutical*
- *power generating plants*
- *marine*

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THOMAS C. WILSON, INC., 21-11 44th Ave., Long Island City 1, N.Y.

Cable address: "Tubeclean," New York

WILSON TW 854

TUBE CLEANERS • TUBE EXPANDERS

STOP *Corrosion with...*

Van-Cor

PLASTIC PIPE, FITTINGS AND FABRICATIONS

★ *Both Chemically Resistant and Impact Resistant Types*

★ *Half the Weight of Aluminum, with High Tensile Strength*

★ *Readily Formed, Machined, Drawn, Molded or Welded*

AVAILABLE FORMS

SHEETS... 1/32" through 1". PIPE... 1/2" through 8" diameter (10 or 20 ft. lengths). ROUND BARS... 1/4" through 5" diameter (10 ft. lengths). WELDING ROD... 1/8" and 5/32" diameter.

TYPICAL APPLICATIONS

A rigid non-plasticized polyvinyl chloride, Van-Cor is fabricated into such products as: Ducts, Hoods, Chemical Tanks, Tank Liners, Plating Racks, Fume Stacks and Piping.

WRITE FOR ILLUSTRATED BULLETIN, SPECIFICATIONS, AND NAME OF NEAREST DISTRIBUTOR

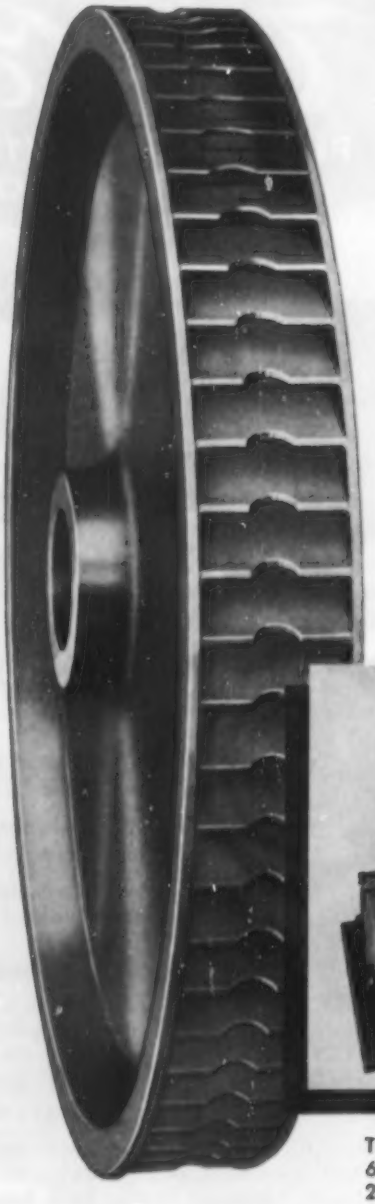
INDUSTRIAL DIVISION OF

COLONIAL PLASTICS MFG. CO.

SUBSIDIARY OF THE VAN DORN IRON WORKS CO.

2685 EAST 79th STREET • CLEVELAND 4, OHIO

TERRY SOLID-WHEEL *SIMPLICITY* MEANS *SUSTAINED* HP



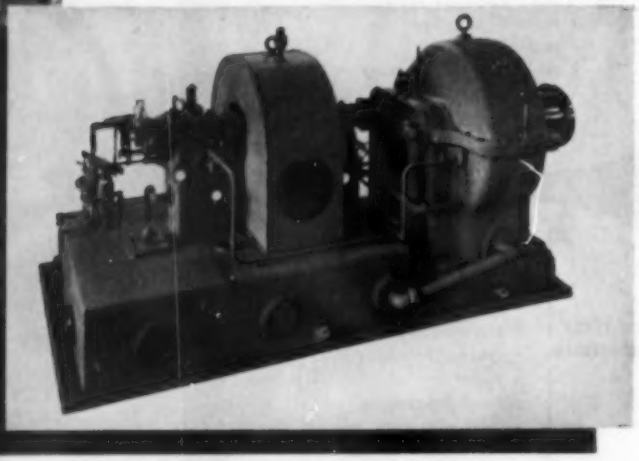
A Terry solid-wheel turbine is simplicity itself. Particularly the rotor. This is a single forging of special composition steel. And, unlike a built-up wheel, has no separate parts to loosen or work out.

Blade wear which might occur after years and years of usage is of little consequence, because the power-producing action of the steam takes place on the curved surfaces at the backs of the buckets. Thus wear does not materially affect horsepower or efficiency.

The blades can't foul. There is a one inch clearance on either side of the wheel and, in addition, the blades are double rim protected. There is no need for close axial blade clearance, because the steam enters the buckets at right angles to the shaft.

Perhaps you, too, can profit from Terry solid-wheel stamina. Bulletin S-116 gives complete details. Send for a copy today.

TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONNECTICUT



This Terry solid-wheel turbo-geared unit is rated 600 hp, 4000/650 rpm for 820 psi, 825°F steam with 275 psi back pressure.

TERRY

ST-1283

What's New in Manufacturers' Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.

Liquid level gauges for indicating, recording, controlling, and telemetering, are described in a new 26-page bulletin just released by The Bristol Company of Waterbury, Conn.

The well illustrated, two color bulletin shows float-type, pressure-type, differential pressure-type, and bubbler-type liquid and water level gauges, in both strip and round-chart models. Also described is a new weather-proof case for the 8- and 12-inch round chart recorders and controllers. Other new instruments featured include a Time-Liquid Level program controller, and a new miniature graphic-panel Metagraphic pneumatic transmission instruments for liquid and water level measurements.

Engineering data on the choice of the proper bulb and instrument for a given installation are presented, as well as installation information on liquid level telemetering and remote control.

Your copy of this informative bulletin, L701, is available now. Just . . .

Circle E15 on Postcard

Stainless steel tubing for heat exchangers and condensers is the subject of a new brochure just published by Republic Steel Corporation, Steel and Tubes Division.

Two typical specifications, A.S.T.M. A-249 and A-269, covering this grade of tubing have been broken down paragraph by paragraph to show just how ELECTRUNITE Tubing is processed to meet each requirement in the specifications. Photographs are used showing various production operations in accordance with specifications.

This brochure, HES-1, is available without charge now. Just . . .

Circle E16 on Postcard

A unique folder containing newly-revised bulletins and Reference Chart describing stainless and corrosion resistant alloys, carbon molybdenum steel, chrome-molysteel, valve trim alloys, straight chromium steels, Columbium stabilized alloys, 18-8 Chrome nickel alloys, 25-12 chrome nickel alloys, 28-10 chrome nickel alloys, a series of nickel-chromium-molybdenum low alloy steels, and a description of shell molding, is available now from Lebanon Steel Foundry.

Consideration for everything, down to the Dewey decimal classification, has been given in this informative folder. Your copy is available now. Just . . .

Circle E17 on Postcard

Load Cells and Load Beams (Baldwin SR-4) for electrical measurement of weight and force are presented in a new 20-page Bulletin just published by Baldwin-Lima-Hamilton Corporation. In addition to a complete description of the SR-4 line, principles of measurement, specifications of load sensitive devices, available instrumentation, and many typical applications are included. For your copy of this informative bulletin, just . . .

Circle E18 on Postcard

General purpose control devices are the subjects of a new 68-page catalog recently announced by General Electric Company's general purpose control department.

Designated GEC-1260A, the two-color publication contains photographs, book prices, wiring diagrams, and dimensions on motor starters, contactors, relays, solenoids, switches, push buttons, and pilot devices. Also included is information comparing applications and merits of manual and magnetic control, and across-the-line and reduced-voltage control.

Your copy is available now. Just . . .

Circle E19 on Postcard

Technical and engineering service bulletins covering a wide scope of subjects are available now from Solvay Process Division of Allied Chemical & Dye Corporation. The following bulletins are available now:

a. Calcium Chloride in Refrigeration
b. Soda Ash
c. Caustic Soda
d. Liquid Chlorine
e. Alkalies and Chlorine in the Treatment of Industrial Water
f. Analysis of Alkalies
g. Water Analysis
h. The Analysis of Liquid Chlorine and Bleach
i. Chlorine Bleach Solutions
j. Calcium Chloride.

To receive your copy of any of these bulletins, simply write the letter corresponding to the bulletin or bulletins you desire on the reader service card, and . . .

Circle E20 on Postcard

A new brochure on lubricated plug valves is available now from Ohio Injector Company. This well-illustrated bulletin demonstrates new OIC lubricated plug valve features and descriptive cutaway drawings. In addition, general dimensions, availability, service recommendations, and specifications, as well as accessories, are given in this brochure. To receive a copy, just . . .

Circle E21 on Postcard

Stainless steel equipment for laboratory and chemical processing is the subject of a completely new 16-page catalog just issued by P & H Sales Corporation, representing Peck & Harvey Manufacturing Corporation.

This new catalog features a complete line of custom-built stainless steel sinks, tanks, trays and accessories available at standard stock-unit prices. It offers free dark room layout service without obligation.

The equipment described should find many applications in the research, production, and testing laboratories throughout the refining, natural gasoline, and petrochemical industries.

To receive your copy of this bulletin, just . . .

Circle E22 on Postcard

Rotameter kits for research laboratory, pilot plant and field testing, are described and illustrated in a new 8-page bulletin just released by Brooks Rotameter Company.

Models described include single meter full-view and Show-Rate Kits, high pressure kits with gauge glass construction, triple meter kits, multitube units in single meter body, all glass meters with a variety of connections, and a special high capacity kit.

Your copy of this bulletin, No. 140 is available now. Just . . .

Circle E23 on Postcard

Packaged chemical feed systems for general water treatment requirements is the subject of a new catalog recently released by Philadelphia Pump and Machinery, subsidiary of American Meter Company.

The Phila-Feeder Pump, a low cost proportioning pump with many qualities not found in other pumps in its price class, is illustrated and described in detail.

These units, for proportioning either one or two different chemicals into the plant system, are complete units comprised of single or divided tanks of from 25 to 200 gallon capacity equipped with simplex or duplex Phila-Feeder Pumps for accurate proportioning of from a few cc. to 18.6 gph.

In addition, special manual or automatic control equipment including the Philatrol mechanism is available to meter chemical flow in exact ratio to specific requirements of boiler water feed or for chemical reactions.

Your copy of this informative catalog is available on request. Simply . . .

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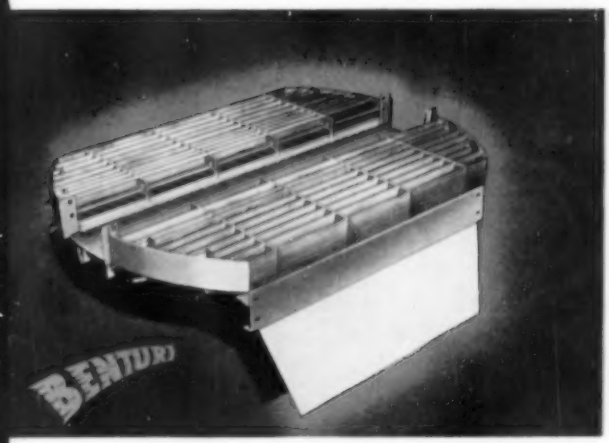

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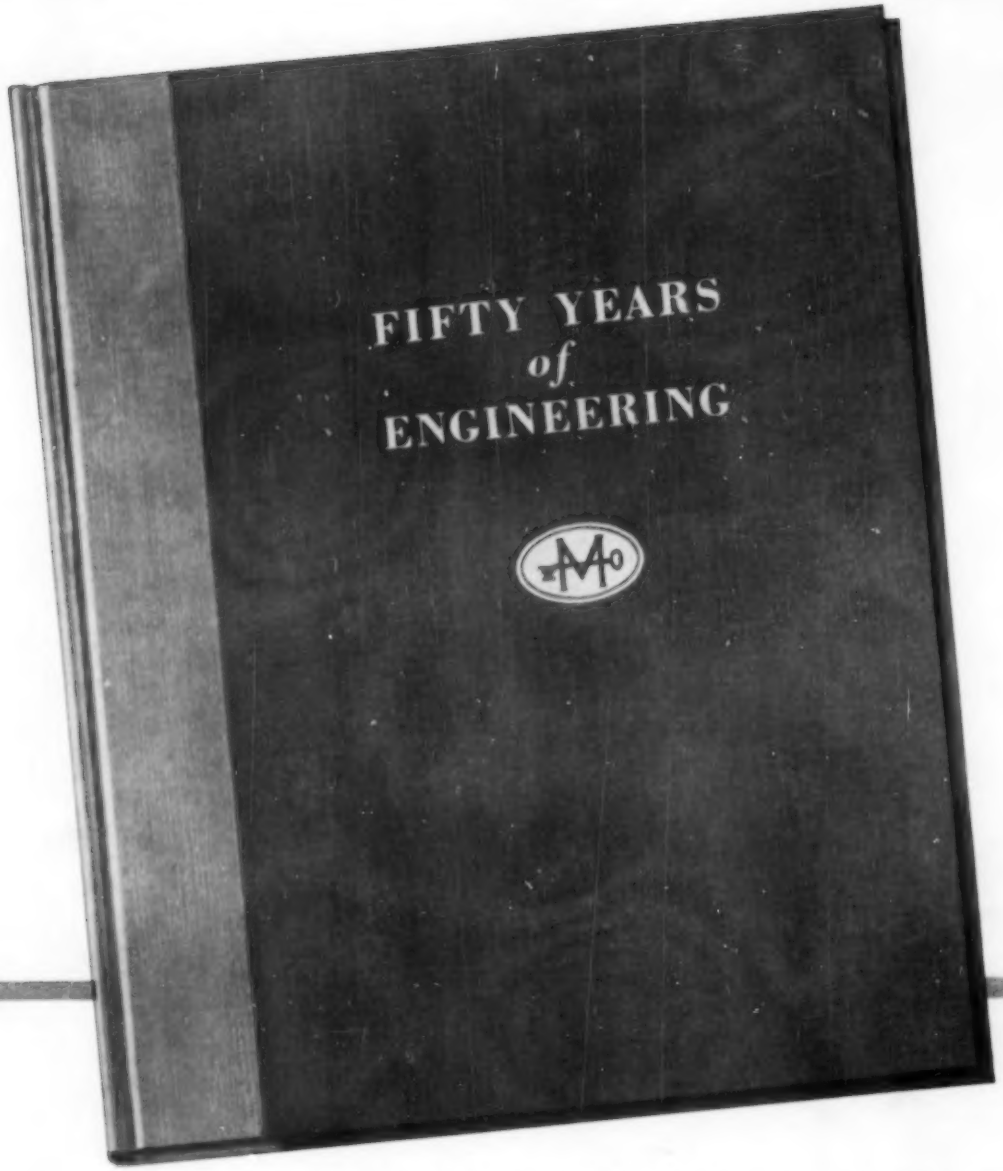

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